

**Appendix B2. Salt Transport Modeling for the Delta
Wetlands Project**

Appendix B2. Salt Transport Modeling Methods and Results for the Delta Wetlands Project

SUMMARY

This appendix describes the methods and results of modeling the effects of the Delta Wetlands (DW) project on Delta salt transport and contributions of inflow sources to salinity in Delta outflow and exports based on the mass-balance water quality module of the Resource Management Associates (RMA) Delta model. The RMA Delta model results were used to estimate mixed concentrations of water quality constituents at selected Delta locations for each DW alternative and the No-Project Alternative.

The appendix describes net inflow and outflow inputs to the model, estimation of tidal mixing exchange, and calculation of inflow concentrations of water quality constituents. RMA model reliability is confirmed through comparison of simulations of historical monthly electrical conductivity (EC) values with EC data from several Delta locations, and the general accuracy of the model is discussed. The RMA Delta model results were incorporated into the Delta Drainage Water Quality (DeltaDWQ) impact assessment model. Results of DeltaDWQ simulations to determine effects of DW operations on concentrations of water quality constituents at key Delta locations are presented for each DW project alternative and the No-Project Alternative.

Background

Appendix B1, "Hydrodynamic Modeling Methods and Results for the Delta Wetlands Project", describes hydrodynamic modeling of the DW project performed by RMA using its link-node hydrodynamic model of the Delta. As described in this appendix, RMA also performed salt transport modeling under contract to DW and provided modeling results to Jones & Stokes Associates (JSA) for use in the impact analysis for water quality performed for this environmental impact report/environmental impact statement (EIR/EIS).

Previous salt transport modeling performed by RMA was used by JSA in preparing the 1990 draft EIR/EIS on the DW project. That modeling focused on five study years (1964, 1972, 1975, 1976, and 1978), representing each of the five hydrologic year types classified under the criteria of California State Water Resources Control Board's (SWRCB's) Water Right Decision 1485 (D-1485). A detailed description of the RMA model and its use for the 1990 draft EIR/EIS is provided in Smith and Durbin (1989). The major features of the RMA salt transport model are described in this appendix.

For preparation of this revised draft EIR/EIS on the DW project, RMA performed new modeling of historical Delta conditions based on historical inflows and exports for water years 1968-1991. The 1968-1991 period was selected because of the availability of historical EC data for confirmation of model results and because almost all major Central Valley Project (CVP) and State Water Project (SWP) facilities were operational during this period.

As described in Appendix B1, some of the simulated Delta channel flows may have been slightly different from the historical flows because of differences in Delta Cross Channel (DCC) gate openings and operations of the barrier at the head of Old River and uncertainty in estimated channel depletion values (Appendix C4, "Delta-DWQ: Delta Drainage Water Quality Model"). Also, the historical island flooding events were not included in the RMA model simulation of historical Delta EC patterns. Nevertheless, the comparison of historical EC data with the RMA model simulations of historical EC values provides the basis for determining the adequacy of these simulations for impact assessment purposes. The simulated response of EC at selected locations to changes in Delta outflow is particularly important for water quality impact assessment of the DW project.

Purpose of This Appendix

The general goal of the salt transport modeling described in this appendix was to simulate salt transport in the Delta over a wide range of monthly inflows, exports, and outflows to determine likely changes that would be caused by additional diversions to and discharges from the DW project islands. Following are the major sections of this appendix and the purpose of each:

- "Formulation of the RMA Delta Water Quality Module" describes the salt transport modeling methodology used by RMA.
- "Modifications of the RMA Model for Simulation of Historical Delta Conditions" describes modifications made to the RMA Delta model for simulations of historical Delta conditions, including using monthly average input data for long-term simulations, performing inflow source tracking, adding simulations of EC and chloride ion (Cl⁻) concentration, and using flow regressions to determine inflow concentrations.
- "Confirmation of Historical Monthly Salinity Simulations" provides confirmation of model simulations by comparing historical EC data with water quality module results of EC predicted using historical Delta flows and exports for the 1968-1991 period. The relationships between effective Delta outflow and both measured and simulated EC are described.
- "Impact Assessment Results for the DW Project Alternatives" presents results of the salt transport simulations for the DW project alternatives in comparison with results for the No-Project Alternative.

FORMULATION OF THE RMA DELTA WATER QUALITY MODULE

The RMA Delta model consists of a link-node hydrodynamic module and a mass-balance water quality module. The model represents the Delta as a network of links (channels) and nodes (volume elements). The link-node module, a branched one-dimensional formulation, simulates average velocity and flow in each specified channel cross section (model link) during the specified tidal cycle and average stage (elevation above or below mean sea level) for each volume element (model node)

(Appendix B1). The mass-balance module of the RMA Delta model was formulated and used to simulate Delta salt transport and estimate average mixed concentrations of water quality constituents in each volume element.

Water quality module simulations are based on results of the hydrodynamic module simulations. The Delta channel tidal flows simulated with the hydrodynamic module are used to estimate daily tidal mixing (mixing of water caused by fluctuating tidal flows) and net daily flows between volume elements (model nodes). Mixed concentrations of water quality constituents are simulated in the water quality module based on these hydrodynamic module results.

Mass Balance with Net Flows and Tidal Mixing

The RMA water quality module estimates the mass balance for each water quality constituent to calculate a daily mixed concentration for each of the volume elements (model nodes), based on the net flows between nodes calculated in the hydrodynamic module and on tidal mixing between volume elements. Tidal mixing is estimated based on tidal flows in the channels (links) connecting volume elements (nodes). As described in Appendix B1, monthly average inflows and exports are used to simulate flows in Delta channels.

The hydrodynamic module tracks water moving into and out of a volume element (node). The water quality module computes mass balances of water quality constituents in each node by combining flow rates with appropriate concentrations for the water quality constituents. Figure B2-1 illustrates the mass-balance terms for a typical model node. Water quality concentrations are simulated using a daily time step within the month, but end-of-month values are reported as the most appropriate results from simulations of monthly average flows.

Inflows and Outflows

Because the RMA water quality module uses net daily flows, the volume of each element can be considered as a constant representing mean water elevation conditions.

For a constant water volume, the sum of all inflows must equal the sum of all outflows. Inflows include net flows from other volume elements, river inflows at upstream boundaries, agricultural drainage, and rainfall onto the water surface. Outflows include net flows to other

volume elements or across the downstream boundary, agricultural diversions (or Delta export), and evaporation from the water surface. Tidal mixing exchanges are also included in the water budget but they represent equal flows moving in both directions (i.e., no net change in flow). (Tidal mixing exchange flows are explained in the next section.)

For the change in concentration of a water quality constituent within a volume element (node) to be calculated, inflowing concentrations must be combined with water flow rates. The outflowing concentration is assumed to be the average mixed concentration of the volume element for the previous time step. Average mixed concentrations of surrounding volume elements for the previous time step are used for net inflows from other volume elements and tidal exchange flows between adjacent volume elements. Rainfall is assumed to have a concentration of zero. The agricultural drainage concentration must be estimated separately, as described below under "Agricultural Drainage Salt".

Tidal Mixing Exchange

Tidal mixing exchange flow is the portion of tidal flow that causes mixing of concentrations between adjacent model segments. Tidal mixing exchange flows must be estimated from tidal flow characteristics and geometry for each connecting channel (model link). Tidal mixing exchange flow is a two-way flow between model elements that is related to the dispersion coefficient as follows:

$$\text{TME (cfs)} = \text{area (ft}^2\text{)} \times D \text{ (ft}^2\text{/sec)} / (2 \times \text{length [ft]})$$

where:

TME = tidal mixing exchange flow, in units of cubic feet per second (cfs);

area = cross section of the connecting channel (link), in units of square feet (ft²);

D = dispersion coefficient as normally used in one-dimensional mixing studies, in square feet per second (ft²/sec); and

length = length of the connecting channel.

In the RMA water quality module, the dispersion coefficient is assumed to be proportional to the average tidal velocity for each link. The module has an additional term for circulation induced by the longitudinal salinity

gradient. The term for circulation induced by the salinity gradient is small compared with the tidal velocity term in most parts of the Delta.

Measured values of the dispersion coefficient generally range between 200 ft²/sec and 2,000 ft²/sec (Fischer et al. 1979). Following is the equation used to estimate the dispersion coefficient in the RMA water quality module:

$$D \text{ (ft}^2\text{/sec)} = (C \times \text{tidal flow parameter}) + (K \times \text{salt gradient})$$

where:

C and K are empirical coefficients used in the RMA dispersion formulation that are estimated during calibration (Smith and Durbin 1989).

Tidal flow parameter is estimated from average tidal velocity to be

$$(|\bar{u}| + \sigma_u) / R^{0.43}$$

where:

$|\bar{u}|$ = tidal average absolute velocity (ft/sec);

σ_u = standard deviation of tidal velocity (ft/sec); and

R = hydraulic radius (ft), equal to channel cross-sectional area divided by channel perimeter.

Salt gradient = measure of the longitudinal change in salinity, in units of parts per million per foot (ppm/ft).

Dispersion coefficients estimated in the RMA water quality module range from about 300 ft²/sec to 900 ft²/sec.

As indicated above, in the RMA water quality module, the dispersion coefficient is multiplied by the cross-sectional area of a channel to yield the tidal mixing exchange flow. Because both $|\bar{u}|$ and σ_u have a linear correlation to tidal velocity, tidal mixing exchange flow is proportional to tidal flow. The exchange flow is generally 1%-5% of tidal flow. Figure B1-14 (in Appendix B1) shows the magnitude of average flood tide flows in Delta channels, indicating the relative strength of the tidal mixing exchange in these channels. Channels with high tidal flows will have greater simulated tidal mixing exchanges between volume elements.

The assumption that tidal mixing exchanges are largely controlled by tidal flows and do not depend strongly on the salt gradient itself allows the model to be used for water quality constituents other than salt. Tidal mixing exchange occurs between volume elements in the RMA model regardless of the magnitude of the salt gradient.

Downstream Boundary for Tidal Salt Exchange

A net outflow of water and a large tidal mixing exchange are simulated at the downstream boundary of the RMA Delta model (node 361) near Benecia. A tidal exchange formula (Fischer et al. 1979) is used to estimate the downstream concentrations of San Pablo Bay water quality constituents for use in the tidal exchange term. A mass balance of the downstream node is estimated from the ebb and flood tidal flows and freshwater outflow. The concentration of the flood tide flow represents a mixture of the ebb flow and a specified constant downstream (San Pablo Bay) concentration. The ebb flow is assumed to have a concentration proportional to that of the downstream node concentration. The boundary condition is calibrated through adjustment of the proportional coefficient.

In the RMA water quality module, San Pablo Bay EC is assumed to be constant at 31,700 microseimens per centimeter ($\mu\text{S}/\text{cm}$), or 31.7 milliseimens per centimeter (mS/cm) (containing total dissolved solids [TDS] at a concentration of 22,000 milligrams per liter [mg/l] and Cl^- at 11,600 mg/l). Flood tide flows are assumed to be a 1:1 mixture of the previous ebb flow (outflow) and San Pablo Bay water. The model represents a characteristic relationship between outflow and the EC value at the downstream node (node 361) as an exponential decrease in EC with increasing Delta outflow (called a negative exponential relationship). However, the maximum simulated boundary EC is 31.7 mS/cm for an outflow of 0 cfs.

Figure B2-2 compares the results of the downstream salt boundary formulation simulated by the RMA water quality module with historical Delta flows and historical monthly average EC data from Benecia. At the lowest historical monthly average Delta outflow of about 2,000 cfs, the module simulated an EC value of about 26,000 $\mu\text{S}/\text{cm}$ (26 mS/cm) for Benecia (node 360). With Delta outflow of 20,000 cfs, the simulated EC value at Benecia is about 11,000 $\mu\text{S}/\text{cm}$ (11 mS/cm). At Delta outflow of 40,000 cfs, the simulated EC value at Benecia is approximately 5,000 $\mu\text{S}/\text{cm}$ (5 mS/cm).

Historical EC measurements from Benecia are presented as monthly averages of the daily means. The measured historical Benecia EC data and the RMA simulation results for node 360 have similar relationships to Delta outflow (Figure B2-2). The basic pattern observed and simulated at Benecia is an exponential increase in EC with decreasing flow. The match is most important at relatively low Delta outflows (less than 20,000 cfs), when salinity intrusion is greatest and EC is highest.

Figure B2-2 also shows the relationship between Delta outflow and simulated EC values at Pittsburg (node 356), just upstream of Chipps Island. This simulated relationship is quite similar to that between Delta outflow and historical mean monthly EC values at Pittsburg. The RMA model's simulation of tidal mixing exchange at the downstream boundary and in Suisun Bay between Benecia and Pittsburg has been calibrated to provide a good match with the general pattern of historical monthly EC data as summarized by the relationships between Delta outflow and EC values at these locations. Additional comparisons of simulation results with measured EC data are described below under "Confirmation of Historical Monthly Salinity Simulations".

The historical monthly average EC data from Benecia and Pittsburg appear more scattered than the simulated values on the graph of the relationship between Delta outflow and EC. Some of this scatter can be explained by the concept of effective outflow, which incorporates the sequence of previous Delta outflows. Effective outflow is defined as the steady outflow that would produce the salinity gradient location observed in the historical EC data. The salinity gradient location in Suisun Bay is governed by the balance between Delta outflow and tidal mixing of salinity from San Pablo Bay. During periods of steady outflow, the mean salinity gradient becomes stationary at a location that depends on Delta outflow. However, an increase or decrease in outflow will not immediately change the location of the salinity gradient; its movement can be described in terms of effective outflow, which depends on antecedent conditions.

Contra Costa Water District (CCWD) has suggested a method for estimating the effective Delta outflow to describe salinity intrusion effects in the Delta (Denton 1993a). The method involves using a relatively simple "routing" equation to calculate the equivalent steady outflow for each month, based on the previous month's effective outflow and this month's estimated average outflow. If this adjustment is made to the historical monthly average Delta outflow estimates and the historical monthly average EC data are plotted against effective outflow rather than historical outflow, these data from Benecia and Pittsburg more closely follow the expected negative

exponential relationship with outflow, as shown in Figure B2-3. The suggested method for adjusting outflows to obtain the effective Delta outflows is described below under "Relationships between Electrical Conductivity Data and Effective Delta Outflow".

Upstream Inflow Concentrations

Inflow concentrations of water quality constituents must be specified for each upstream inflow to the RMA model: Sacramento River and Yolo Bypass, eastside streams, and San Joaquin River.

Historical EC measurements are available for inflows from the Sacramento and San Joaquin Rivers. Future inflow sequences may differ from historical sequences, however, because of changed operation of upstream reservoirs and changed upstream diversions. For planning studies based on future sequences of simulated inflows, historical EC sequences cannot be used. Instead, the historical EC data are related to flows using flow regressions, and the flow regressions are used to estimate the corresponding EC values from the simulated inflows. Flow regressions for Sacramento and San Joaquin River inflow EC values are described below under "Flow Regressions for Inflow Concentrations".

Agricultural Drainage Salt

In the Delta, EC values in agricultural drainage water vary seasonally and depend on the water and salt management practices on each island. The EC values of the agricultural diversions from the Delta channels to the islands depend on seasonal salinity intrusion and EC values in inflowing rivers. Agricultural islands do not represent large net sources of salt, although the islands may receive some residual salt from fertilizers and dissolution of soil minerals. EC values in drainage water are related primarily to the seasonal buildup of salt in agricultural fields resulting from evapotranspiration (ET); this salt is subsequently removed from the soils by rainfall or water applied for salt leaching in winter.

The RMA model tracks the water and salt budget for each Delta island, assigning diversions and drainage flows to the appropriate model nodes. The monthly volume estimates for applied and drained water for the lowland and upland portions of the Delta are obtained from the DeltaDWQ model described in Appendix C4, "DeltaDWQ: Delta Drainage Water Quality Model", and are included in the input file for the RMA Delta model.

The increased salt concentrations in drainage water caused by ET are simulated with the RMA water quality module.

Irrigated Delta lowlands encompass about 340,000 acres, and irrigated Delta uplands encompass about 140,000 acres. Agricultural diversions and drainage flows can be quite large during the irrigation season. Only rough estimates of the actual drainage and diversion flows are available. Therefore, possible inaccuracies in these specified flows may have a relatively large effect on simulations of Delta outflow volumes and corresponding salinity intrusion events during low-flow periods.

For example, 1 inch of drainage or diversion volume from 480,000 acres is equivalent to a flow of about 675 cfs for a month. Because it is likely that the available estimate of net channel depletion in the Delta is only moderately accurate (± 0.5 inch per month), the resulting estimates of Delta outflow may easily be 500 cfs higher or lower than actual Delta outflow.

An additional uncertainty in the simulation of Delta agricultural drainage effects results from the magnitude of seasonal buildup and discharge of soil salinity from irrigation, ET, rainfall, and leaching practices being unknown (see Appendix C2, "Analysis of Delta Agricultural Drainage Water Quality Data"). The RMA model represents an accurate salt budget for each Delta island, but the seasonal patterns of drainage volume and drainage EC values are only approximate average conditions for the Delta.

MODIFICATIONS OF THE RMA MODEL FOR SIMULATION OF HISTORICAL DELTA CONDITIONS

Several modifications to the RMA Delta model were made for the simulations of historical Delta conditions:

- JSA developed input data for long-term (25-year) RMA simulations based on 1967-1991 monthly average Delta inflows and exports.
- The RMA model tracked each of the river inflows, Delta agricultural drainage, and seawater intrusion from the downstream model boundary throughout the Delta to calculate source water contributions.
- The RMA model tracked Cl^- concentration and EC along with TDS, the traditional modeled variable for salinity. JSA used flow regressions

to estimate EC and concentrations of Cl⁻ in each river inflow.

- The RMA model calculated salt balances for each DW island and each Delta agricultural island to estimate drainage concentrations.

The following sections describe these modifications for long-term monthly average historical simulations.

Long-Term Simulations

For the current EIR/EIS analysis, results of long-term RMA model simulations were used to estimate Delta levels of EC and concentrations of Cl⁻ and bromide ion (Br⁻). Values for other water quality constituents were estimated using a combination of direct simulation performed by the water quality module and flow weighting of source concentrations based on source tracking simulated by the water quality module. Monthly average inflows were used to simulate monthly average net flows in Delta channels using the RMA hydrodynamic model (Appendix B1). Inflow water quality is held constant during the month. The water quality constituents were simulated with daily time steps within the month, but only the end-of-month values are reported.

The long-term simulations allow the Delta water quality patterns to be compared under a wide range of Delta flow conditions. Seasonal effects and long-term effects from drought sequences are simulated within the 25-year period.

Source Tracking with Modeled Dye

The RMA model was used to track Delta inflows, seawater intrusion, DW discharges, and Delta agricultural drainage from their sources to various Delta locations. Based on the source tracking analysis, other Delta water quality constituents could be evaluated if their inflow concentrations are known.

Source tracking was accomplished through simulation of movements of conservative (nondecaying) dye tracer having a constant inflow concentration at each inflow location. Concentrations of the dye simulated at other locations in the Delta reflect the proportional contribution of water at that location from the inflow source being tracked. The RMA model produced end-of-month modeled dye concentrations corresponding to average monthly net flow patterns.

Seawater intrusion volume tracking was performed using a seawater salt simulation that tracked only salt moving upstream from the downstream boundary. Salt tracking was used because water source tracking from the downstream boundary involves small flow percentages. The seawater source contribution was estimated by dividing the simulated seawater salt concentration by the salt concentration for seawater from San Pablo Bay (11,600 mg Cl⁻ per liter of seawater).

Each DW island discharge was tracked to the selected destinations with modeled dye simulations. Although individual DW island discharges were tracked, only the aggregate contribution from DW project discharges is reported.

All Delta agricultural discharges were dyed and tracked with another modeled dye simulation. More dye simulations could be used to track discharges from other selected locations. Although the source tracking was performed with the RMA water quality module, the simulation results are described in Appendix B1, "Hydrodynamic Modeling Methods and Results for the Delta Wetlands Project", because these results are primarily used to identify the effects of hydraulic flow transport from each source of water. The seawater intrusion effects are described in this appendix.

Addition of Electrical Conductivity and Chloride Variables

TDS is the salinity variable that has been traditionally used in the RMA water quality module, although relatively few measurements of TDS are available for the Delta. In contrast, several EC monitoring stations throughout the Delta provide continuous EC records. For model calibration purposes, modeling EC directly is a more reliable approach than modeling TDS and estimating EC values with a regression equation. Therefore, the RMA model was modified to include direct EC modeling.

The RMA water quality module was also modified to simulate Cl⁻ concentrations directly to allow accurate estimates of Br⁻ concentrations; Br⁻ in seawater and in the Delta is present at a constant bromide-to-chloride (Br⁻/Cl⁻) ratio of about 0.0035. In addition, the Cl⁻/EC ratios vary between the Sacramento River, the San Joaquin River, and San Pablo Bay (seawater). When both Cl⁻ and EC are modeled, the simulated Cl⁻/EC ratio at various Delta locations can be used to estimate the proportional contributions of water from these three

sources. Measured Cl⁻ and EC values can then be used to confirm the modeled mixtures from these sources.

Flow Regressions for Inflow Concentrations

The RMA Delta model was used to simulate conditions based on historical monthly inflows and exports. A method was needed to estimate the inflow salinity (expressed as TDS and Cl⁻ concentrations and EC) for each river inflow. Flow regressions were used to estimate monthly average EC values; ratios between other variables of interest and EC were used to estimate inflow concentrations for the other variables at each inflow location.

Figure B2-4 shows the monthly average EC data for the Sacramento River at Greene's Landing for the 25-year historical period (1967-1991) used in the RMA historical simulations. These measurements were collected by various agencies and aggregated in a single computerized database by CCWD (Leib pers. comm.).

Measured mean monthly Sacramento EC values ranged only from about 100 $\mu\text{S}/\text{cm}$ to 260 $\mu\text{S}/\text{cm}$. A definite flow dilution pattern is evident, as shown in the relationship between EC and flow in Figure B2-4, although there is considerable scatter in the data.

To estimate monthly average Sacramento River EC as a function of average monthly flow, JSA empirically fit the following equation to the monthly average EC data set:

$$\begin{aligned}\text{Sacramento River EC } (\mu\text{S}/\text{cm}) \\ = 5,000 \cdot \text{flow (cfs)}^{-0.35}\end{aligned}$$

This equation represents the approximate relationship between Sacramento River inflow and EC, especially for flows of less than 25,000 cfs, those most likely to correspond to low Delta outflow and high salinity intrusion. The equation's flow exponent of -0.35 corresponds to a dilution effect with increasing flow. For example, as flow doubles from 12,000 cfs to 24,000 cfs, EC decreases from 180 $\mu\text{S}/\text{cm}$ to about 130 $\mu\text{S}/\text{cm}$ (Figure B2-4).

In the RMA simulations, Yolo Bypass EC was assumed to be the same as Sacramento River EC for each month. A similar flow regression equation for EC was estimated for the eastside streams, although field data are limited. The eastside streams had an average simulated EC value of about 105 $\mu\text{S}/\text{cm}$.

Figure B2-5 shows the monthly average EC data for the San Joaquin River at Vernalis for 1968-1991. The EC values fluctuate over a much greater range, from about 150 $\mu\text{S}/\text{cm}$ at high flows to more than 1,500 $\mu\text{S}/\text{cm}$ at low flows in 1977. Although high flows produce a strong dilution effect that is adequately represented by a flow regression equation, considerable data scatter at low flows cannot be explained by a simple flow dilution relationship. Nevertheless, the following equation is used to estimate San Joaquin River EC as a function of average monthly flow:

$$\begin{aligned}\text{San Joaquin River EC } (\mu\text{S}/\text{cm}) \\ = 25,000 \cdot \text{flow (cfs)}^{-0.5}\end{aligned}$$

The simulations of historical salinity conditions performed with the RMA model used these flow regression equations to estimate the EC of river inflows. Use of these regression equations introduces potential errors in simulated EC values at Delta locations where river inflows have strong influences. For example, in the winters of 1988, 1989, and 1990, the San Joaquin River EC values estimated using the flow regression equation were less than 800 $\mu\text{S}/\text{cm}$; the actual values were considerably higher (Figure B2-5). Because the estimated inflows will be the same for each DW alternative analyzed, potential errors in the regression estimates of inflow EC will not change the impact assessments.

Estimating inflow EC values as a function of river flow provides the most appropriate method for estimating inflow EC for Delta planning studies and impact assessments of project alternatives when the simulated inflows are expected to be different from historical inflows because of the operations of reservoirs and other upstream facilities and changes in Delta export demands.

Agricultural Diversions and Drainage Salt Balance

Agricultural drainage is generally considered to have a large effect on salinity (TDS, EC, and Cl⁻) in the central and southern Delta near the CCWD diversion and CVP and SWP export pumping locations. For accurate simulation of probable effects of agricultural drainage on salinity, the water and salt balances for the Delta agricultural area must be specified properly.

The RMA Delta model was modified to account for water and salt mass balances on each Delta island. Estimates of diversions, storage (as soil moisture or leaching water), ET, rainfall, and discharge of water for each Delta

island or tract are used to estimate salt concentrations in Delta-wide agricultural discharges.

Water budget terms for the Delta uplands and lowlands were separately obtained from DeltaDWQ model simulations (Appendix C4). Concentrations in the monthly diversions were calculated from the appropriate model nodes supplying water to each Delta island. Island water budgets were assumed to be proportional to land area. The monthly water balance terms, specified as inches per month in the input file, were converted to flows at appropriate model nodes. An individual island may divert from and discharge to several different nodes. Nodes may supply diversion water or receive drainage from several different islands.

Relationships between islands and model nodes were obtained from data developed by the California Department of Water Resources (DWR) for its Delta simulation model (DWRDSM), which has a similar mass-balance accounting for agricultural drainage. The major uncertainty in this formulation is not the spatial relationships between islands and model nodes, but the unknown water balance and corresponding salt budget terms for each island. Seepage, applied water, and subsequent drainage volumes are thought to differ substantially between Delta islands depending on soils, major crops, and agricultural practices (DWR 1995).

Discharge concentrations also depend on the effectiveness of drainage water in removing accumulated salt from Delta island soils. Winter leaching practices and rainfall drainage are very effective in removing accumulated salts from the soils. Drainage of unused applied irrigation water in the summer is much less effective in removing salts because this water generally remains in irrigation and drainage canals.

The RMA model simulates the lag between application and removal of salts using an assumed soil-water mixing volume for each island. Because a certain amount of water is retained in the soil according to this relationship, the buildup of soil salt concentration resulting from loss of soil moisture through ET is delayed. Improved formulations that more accurately represent actual agricultural salt budgets in the Delta may be developed (DWR 1995). Nevertheless, the RMA Delta model can be used to account for the general features of the seasonal salt budget in the Delta.

CONFIRMATION OF HISTORICAL MONTHLY SALINITY SIMULATIONS

RMA calibrated the Delta water quality module for the previous modeling used in the 1990 draft EIR/EIS using daily simulations for selected years with significant seawater intrusion events (Smith and Durbin 1989). The only calibration parameters for the salinity (TDS or EC) simulations are the tidal mixing exchange coefficients. RMA adjusted these coefficients using a combination of iterative manual adjustments and automatic adjustments using a "calibration program".

This section compares end-of-month average EC values simulated with the RMA model for historical inflows and exports with historical monthly average EC data to confirm the salinity calibration of the RMA Delta salt transport model. The observed and simulated relationships between effective Delta outflow and EC at selected Delta locations are compared. The differences between end-of-month simulated EC values and monthly average EC data indicate the model errors (uncertainties) that should be considered during impact assessment using simulations of operations of the DW project alternatives and the No-Project Alternative. Because the model uncertainties will be similar for simulations of the No-Project Alternative and the DW alternatives, the model uncertainties will not affect the model estimates of water quality impacts.

Available Electrical Conductivity Data

Daily minimum, average, and maximum EC data recorded at several Delta monitoring stations during 1968-1991 were obtained from CCWD, which had aggregated various agencies' measurements into a single database (Leib pers. comm.). These daily data were summarized as monthly means of the daily minimum, average, and maximum values for comparison with simulated end-of-month EC values.

Numerous EC monitoring stations in the Delta are used in the Interagency Ecological Program for the Sacramento-San Joaquin Estuary. Figure B2-6 shows the locations of the following stations (with monitoring station ID number, indicating river name and kilometer upstream, plus the Interagency Ecological Program [IEP] station code); data from these stations were selected for comparison with the RMA EC simulations:

- Benicia (RSAC056),
- Port Chicago (RSAC063),
- Chipps Island (Mallard Island) (RSAC075),
- Collinsville (RSAC084),
- Emmaton (RSAC092),
- Rio Vista (RSAC101),
- Pittsburg (RSAC077),
- Antioch (RSAN007),
- Jersey Point (RSAN018),
- Old River at Holland Tract (ROLD014), and
- Old River at Tracy Pumping Plant (CHDMC004).

The significance of each monitoring location to this analysis is described below under "Comparison of Simulation Results with Historical Data".

Relationships between Electrical Conductivity Data and Effective Delta Outflow

Because the salinity gradient location in Suisun Bay is governed by the balance between Delta outflow and tidal mixing of salinity from San Pablo Bay, the observed EC at a fixed station is a function of the effective Delta outflow. During periods of steady outflow, the observed daily average EC value will remain relatively constant (with a large tidal fluctuation). The expected mean EC value at a fixed location in an idealized one-dimensional estuary is a negative exponential function of outflow:

$$EC = a \cdot \exp(-\text{outflow} \cdot b)$$

However, the observed EC at a location is not immediately changed by an increase or decrease in Delta outflow. During periods of increasing outflow, the EC will be decreasing but will be higher than expected with calculations based on a steady Delta outflow. During periods of decreasing outflow the EC will be increasing but will be lower than expected with calculations based on a steady Delta outflow. This dynamic change in the observed EC can be approximated as described below with use of a calculated effective (lagged) outflow, which depends on antecedent conditions.

CCWD has suggested a method for estimating the effective Delta outflow for describing salinity intrusion effects in the Delta (Denton 1993a). Once the historical monthly average Delta outflow estimates are adjusted based on this calculation, the historical monthly average EC data from each Delta location more closely follow the expected negative exponential relationship with the effective outflow (as shown in Figure B2-3).

The suggested method for adjusting outflows to obtain the effective Delta outflow is a relatively simple "routing" equation to calculate the equivalent steady outflow for each month, based on the previous month's effective outflow and this month's average Delta outflow. The rate of change in effective outflow is assumed to be proportional to the effective outflow times the change in outflow. Because the impact assessment simulations use monthly average flows, an exponential estimate of the monthly change in the effective Delta outflow is used:

$$\begin{aligned} &\text{Change in effective outflow} \\ &= (\text{outflow} - \text{effective outflow}) \\ &\cdot (1 - \exp[-\text{effective outflow}/R]) \end{aligned}$$

where R is an estimated "response" factor that is approximately 5,000 cfs for monthly average flows.

For example, if the effective Delta outflow is 5,000 cfs, then the response of effective outflow to a change in outflow will be 63% ($1 - \exp[-5,000/5,000]$). If the monthly average outflow increases from 5,000 cfs to 10,000 cfs, the effective outflow will increase to 8,160 cfs ($5,000 \text{ cfs} + 0.63 \cdot 5,000 \text{ cfs}$). If the effective outflow is 20,000 cfs, then the response of effective outflow to a change in outflow will be 98% ($1 - \exp[-20,000/5,000]$). Therefore, the relative adjustments for effective outflow will be greatest during periods of low Delta outflow.

The historical EC data and RMA model simulations of historical EC values are described below relative to the effective monthly average Delta outflow calculated as shown from the historical Delta outflow sequence.

Comparison of Simulation Results with Historical Data

Figures B2-7 to B2-17 compare simulated end-of-month EC values at selected RMA model nodes with monthly averages of measured EC data from nearby monitoring stations. The figures show the time series of monthly values for 1968-1991 and the relationship between EC at the selected locations and the effective monthly average Delta outflow at Chipps Island. Differences between the monthly means of measured daily maximums and minimums characterize the typical daily fluctuations in EC values caused by tidal excursion of the salinity gradient back and forth at the monitoring stations. The RMA water quality module cannot simulate daily variations in EC values caused by tidal movement of the salinity gradient. Mean monthly EC data should corres-

pond, however, with simulated EC values for the historical Delta inflows and exports.

Table B2-1 gives a summary of historical EC data at these locations and the RMA simulation results for EC values near these locations. The table also shows the average difference between each set of simulated and measured values (bias) and shows the average standard deviation of the differences between the RMA simulation results and the mean monthly measured EC. The standard deviation provides a general measure of the average error between the RMA simulation results and the mean monthly measured EC.

Suisun Bay Region

Seawater intrusion from the downstream boundary has the greatest effect on salinity in the Suisun Bay portion of the Delta. The Suisun Bay region encompasses the estuarine "entrapment zone", an important aquatic habitat region associated with high levels of biological productivity (Arthur and Ball 1980). The entrapment zone as defined by Arthur and Ball (1980) is the salinity (EC) range of 5-15 mS/cm, corresponding to 3,330-10,000 ppm (3.3-10 parts per thousand [ppt]) of TDS, assuming a constant ratio of about 1.5 mS/cm EC to 1 ppt TDS. The upstream boundary of the entrapment zone can also be identified as the location of the 2-ppt bottom salinity, or "X2" (measured in kilometers upstream of the Golden Gate Bridge).

Benicia. Historical monthly average EC values for Benicia varied widely, from less than 1 mS/cm at high Delta outflows to approximately 30 mS/cm at low Delta outflows (Figure B2-7) with an average EC of 15.8 mS/cm. Simulated EC values at RMA model node 360 were similar to the observed values for most months.

The general response of EC at Benicia to effective Delta outflow is easily detected in the monthly data and was well represented by the RMA model formulation. The simulated EC range of 5-15 mS/cm at Benicia, characterizing the upstream and downstream extent of the entrapment zone, corresponds with Delta outflows ranging from about 13,000 cfs to about 40,000 cfs. The monthly average observed EC data are more scattered than the simulated EC values but follow a similar relationship with effective monthly average Delta outflow.

Table B2-1 shows that for Benicia, the mean measured EC for the 1968-1991 period was 15,792 $\mu\text{S}/\text{cm}$. The mean of the RMA simulation of historical EC at Benicia (node 360) was 14,604 $\mu\text{S}/\text{cm}$. The RMA-simulated EC was lower than the measured EC by an average

of 1,188 $\mu\text{S}/\text{cm}$. The standard deviation from mean monthly EC measured at Benicia was 3,050 $\mu\text{S}/\text{cm}$ (19% of mean measured EC).

Port Chicago. Figure B2-8 shows the observed and simulated EC values for Port Chicago for 1968-1991. Port Chicago is opposite Roe Island and is the downstream monitoring location for the 1995 WQCP estuarine salinity objectives. Historical EC data for Port Chicago averaged 10 mS/cm. The Port Chicago EC was approximately 5 mS/cm at an outflow of about 15,000 cfs and approximately 15 mS/cm at an outflow of about 5,000 cfs. The monthly average observed EC data are more scattered than the simulated EC values but follow a similar relationship with effective monthly average Delta outflow. Table B2-1 indicates that the mean RMA-simulated EC for Port Chicago was 417 $\mu\text{S}/\text{cm}$ lower than the measured EC, with a standard deviation of 2,337 $\mu\text{S}/\text{cm}$ (23% of mean measured EC).

Chippis Island. Figure B2-9 shows the observed and simulated EC values for Chippis Island for 1968-1991. Chippis Island is usually considered to be the primary station for estimating Delta outflow because it is located downstream of the confluence of the Sacramento and San Joaquin Rivers.

Chippis Island is opposite one of the 1995 WQCP estuarine salinity habitat monitoring locations (Mallard Island) and is therefore an important EC measurement location; however, historical EC data from Chippis Island are only available beginning with 1981. The RMA-simulated EC (node 357) was slightly higher than the measured data, indicating that the measured station is slightly "upstream" of the model node location. Use of the RMA salinity curve to estimate the effective outflow corresponding to various EC values indicates that the Chippis Island station will be within the entrapment zone (5-15 mS/cm) for effective outflows of about 3,500 cfs to 7,500 cfs. X2 (3 mS/cm) would be located downstream of Chippis Island for effective Delta outflows of greater than about 12,000 cfs. Statistics for the Chippis Island station in Table B2-1 indicate that the RMA-simulated EC was 808 $\mu\text{S}/\text{cm}$ greater than measured EC, with a standard deviation of 2,471 $\mu\text{S}/\text{cm}$ (40% of mean measured EC).

Pittsburg. Figure B2-10 shows the observed and simulated EC values for the Pittsburg station, located upstream of Chippis Island.

The relationship between effective outflow and Pittsburg EC was similar for the measured EC and the RMA-simulated EC. The maximum historical monthly average EC was about 15 mS/cm. The Pittsburg station would therefore remain within the entrapment zone for effective

outflows of less than 7,000 cfs, but would be upstream of the entrapment zone at higher outflows. The X2 position would be downstream of the Pittsburg station for effective outflows of greater than about 9,000 cfs.

Table B2-1 indicates that the mean observed EC at Pittsburg for the 1968-1991 period was 4,061 $\mu\text{S}/\text{cm}$, and the mean of the RMA simulation (node 356) was 3,309 $\mu\text{S}/\text{cm}$ (752 $\mu\text{S}/\text{cm}$ less than observed). The standard deviation was 1,777 $\mu\text{S}/\text{cm}$ (44% of mean measured EC). The relationship between effective outflow and EC at Pittsburg was accurately simulated by the RMA model, and simulated incremental effects of changes in outflow on Pittsburg EC values are reliable.

Sacramento River Electrical Conductivity Monitoring Stations

Because most Delta outflow is from the Sacramento River channel, data from these stations are presented first, followed by EC data from stations located along the San Joaquin River.

Collinsville. Figure B2-11 shows the observed and simulated values for the Collinsville EC monitoring station. The Collinsville station is on the Sacramento River, just upstream of the mouth of the San Joaquin River. Montezuma Slough is located near Collinsville, so measurements from this station indicate the salinity of inflows from the Sacramento River to Suisun Marsh. The observed range in mean monthly EC at Collinsville is from less than 1 mS/cm at Delta outflows of greater than 12,000 cfs to greater than 10 mS/cm at Delta outflows of about 3,000 cfs.

Table B2-1 indicates that the observed average EC at Collinsville for the 1968-1991 period was 2,542 $\mu\text{S}/\text{cm}$. The RMA model (node 355) average for the historical simulation was 2,421 $\mu\text{S}/\text{cm}$. The RMA-simulated EC was lower than the measured EC by an average of 121 $\mu\text{S}/\text{cm}$. However, there was considerable scatter in the monthly data, so the standard deviation between the RMA simulations and observed values was 1,190 $\mu\text{S}/\text{cm}$ (47% of measured EC).

Figure B2-11 indicates that Collinsville EC is strongly controlled by effective Delta outflow when outflow is less than about 10,000 cfs. Although there are other factors influencing the Collinsville EC data, the effects of outflow are well modeled by the RMA model. For impact assessment purposes, where the incremental effects of modified outflow on Collinsville EC are to be determined, the RMA results for Collinsville are reliable.

Emmaton. Figure B2-12 shows the observed and simulated EC values for Emmaton. Emmaton serves as a monitoring location for agricultural water quality under the 1995 WQCP Delta objectives. Table B2-1 shows that the mean measured EC at Emmaton was 810 $\mu\text{S}/\text{cm}$. The mean RMA-simulated EC was 532 $\mu\text{S}/\text{cm}$, 278 $\mu\text{S}/\text{cm}$ less than the measured EC, with a standard deviation of 585 $\mu\text{S}/\text{cm}$ (72% of mean measured EC). The EC data from Emmaton show a marked reduction in the extent of salinity intrusion in comparison with the Collinsville EC data. Only during a few periods of low flow in 1977 did the entrapment zone, as defined by the EC range of 5-15 mS/cm (Arthur and Ball 1980), extend up the Sacramento River as far as Emmaton. The entrapment zone has rarely been observed this far upstream. The X2 position (3 mS/cm) would be downstream of Emmaton for effective Delta outflow greater than about 3,000 cfs.

Emmaton is located on the Sacramento River downstream of its junction with Threemile Slough. Emmaton EC data indicate salinity intrusion up the Sacramento River channel and are representative of Sacramento River water entering Threemile Slough and flowing to the lower San Joaquin River, upstream of Jersey Point. Because of large tidal flows in Threemile Slough, there is considerable exchange of San Joaquin River water from upstream of Jersey Point that may influence Emmaton EC.

Rio Vista. Historical monthly EC data from Rio Vista are compared with simulated EC patterns for the 1968-1991 period in Figure B2-13. Elevated salinity at Rio Vista was limited to extreme conditions during 1977.

The historical EC data indicate that seawater intrusion on the Sacramento River was generally not observed at Rio Vista between 1968 and 1991. Therefore, EC conditions at Walnut Grove, near the DCC and Georgiana Slough, can be considered to be about the same as Sacramento River inflow conditions.

San Joaquin River and South Delta Monitoring Stations

Antioch. Figure B2-14 shows the observed and simulated EC values for the Antioch monitoring location. Because the Antioch station is farther upriver than the Collinsville station, EC is consistently lower at Antioch than at Collinsville (Figure B2-11) for the same effective Delta outflow. The scatter in measured and simulated EC values is caused by variations in factors other than effective Delta outflow that influence Antioch EC values.

Antioch and other central and southern Delta locations may be more affected by the variable quality of San Joaquin River inflow and agricultural drainage in the Delta than are locations in the western Delta. Both of these salinity effects are included in the RMA model, but there are differences between simulated and measured EC values for these terms.

As defined by the 5- to 15-mS/cm range in EC values, the entrapment zone extends upstream to Antioch only during periods of Delta outflow less than about 4,000 cfs. The simulated seawater intrusion at Antioch in some summers was greater than measured (Figure B2-14).

Some of the differences between the RMA simulations of historical conditions and the observed EC values during periods of elevated EC measurements may be caused by the uncertainty of estimates of Delta outflow used in the RMA simulations.

Table B2-1 indicates that the average observed EC at Antioch for 1968-1991 was 1,809 $\mu\text{S}/\text{cm}$ and the RMA-simulated EC (node 46) was 1,509 $\mu\text{S}/\text{cm}$ (average of 300 $\mu\text{S}/\text{cm}$ less than observed). The standard deviation of the difference between RMA-simulated and measured EC was 1,123 $\mu\text{S}/\text{cm}$ (62% of mean measured EC).

Figure B2-14 indicates that Antioch EC is strongly controlled by effective Delta outflow when outflow is less than about 7,500 cfs. Although there are other factors influencing the Antioch EC data, the effects of effective Delta outflow are well modeled by the RMA model. For impact assessment purposes, where the incremental effects of modified outflow on Antioch EC are to be determined, the RMA results for Antioch are reliable.

Jersey Point. The Jersey Point EC station is another important location for monitoring Delta agricultural water quality standards under the 1995 WQCP objectives. Figure B2-15 shows historical and simulated EC values for Jersey Point. Although the entrapment zone does not extend upstream to Jersey Point, salinity intrusion (EC value greater than about 0.5 mS/cm) has been observed at this station when Delta outflow was less than 7,500 cfs.

Table B2-1 indicates that the average measured EC at Jersey Point for the 1968-1991 period was 694 $\mu\text{S}/\text{cm}$. The RMA-simulated historical EC at Jersey Point (node 44) averaged 547 $\mu\text{S}/\text{cm}$ (140 $\mu\text{S}/\text{cm}$ less than measured). The standard deviation was 564 $\mu\text{S}/\text{cm}$ (81% of mean measured EC). Figure B2-15 shows that most of the deviation in simulated and measured EC values occur during periods of low effective Delta outflow.

Figure B2-15 indicates that Jersey Point EC is strongly controlled by effective Delta outflow when outflow is less than about 7,500 cfs. Although there are other factors influencing Jersey Point EC, the effects of outflow are well modeled by the RMA model. For impact assessment purposes, where the incremental effects of modified outflow on Jersey Point EC are to be determined, the RMA results for Jersey Point are reliable.

The simulated salinity intrusion at Jersey Point was greater than measured EC data indicated for low outflow conditions. For purposes of impact assessment for the DW project, however, the simulated EC patterns at Jersey Point are sufficiently accurate to represent the general influence of salinity intrusion from Benicia as a function of effective Delta outflow.

Old River at the CCWD Diversion Location.

Figure B2-16 shows historical EC data and EC values simulated by the RMA model for CCWD diversions at Rock Slough. Salinity intrusion events occur during periods of low Delta outflows.

Table B2-1 indicates that the average CCWD EC for the 1968-1991 period was 500 $\mu\text{S}/\text{cm}$. The RMA simulation of historical CCWD EC was 292 $\mu\text{S}/\text{cm}$, considerably lower than measured data. The RMA model appears to underestimate the salinity intrusion effects during periods of low effective Delta outflow. The standard deviation was 210 $\mu\text{S}/\text{cm}$ (42% of mean measured EC).

Figure B2-16 suggests that there is a minimum EC at CCWD's Rock Slough diversion location that is a function of the effective Delta outflow, as observed for the other Delta stations. However, there are many more months with elevated EC values that do not appear to be directly controlled by the effective outflow. San Joaquin River inflow EC and Delta agricultural discharges are two possible influences at this location, in addition to salinity intrusion effects.

Measured EC at Holland Tract, located on Old River just downstream of the mouth of Rock Slough, are shown for comparison with CCWD EC data. The average Holland Tract EC was 419 $\mu\text{S}/\text{cm}$ for the 1968-1991 period (81 $\mu\text{S}/\text{cm}$ less than the average CCWD EC). Differences between these two locations can be attributed to local effects of agricultural discharges and tidal gate leakage between Sand Mound Slough and Rock Slough. During the 1976-1977 drought, when a temporary CCWD intake was established in Middle River, the CCWD measurements were less than the Holland Tract measurements.

Old River at Tracy Pumping Plant. Figure B2-17 shows measured monthly EC data and simulated EC values for the CVP Tracy Pumping Plant. Salinity intrusion (EC value greater than 0.5 mS/cm) at the CVP Tracy Pumping Plant was relatively infrequent and of moderate magnitude during the historical period compared with salinity intrusion at Jersey Point. CVP export EC values, however, are substantially affected by the variable quality of San Joaquin River inflow and agricultural drainage in the Delta (Figure B2-5).

Table B2-1 indicates that the average EC at CVP Tracy Pumping Plant for the 1968-1991 period was 497 $\mu\text{S/cm}$. The mean RMA simulation of historical CVP Tracy Pumping Plant EC was 369 $\mu\text{S/cm}$, considerably lower than measured data. The RMA model appears to underestimate the salinity intrusion effects during periods of low effective Delta outflow. The standard deviation was 150 $\mu\text{S/cm}$ (30% of mean measured EC).

The uncertain effects of agricultural drainage on export EC will not influence the impact assessment results because the simulated effects of San Joaquin River inflow EC and agricultural drainage EC on export EC will be the same for each DW alternative; the impact assessment of effects of DW project operations on likely export EC values will be reliable.

Summary of Relationships between Simulated Electrical Conductivity at Selected Delta Channel Locations and Effective Delta Outflow

The previous section presented the RMA simulations of Delta EC for historical inflow and export conditions. The dominant controlling factor at each channel location was effective Delta outflow. Figure B2-18 shows the resulting negative exponential relationship between effective Delta outflow and EC at several of the EC monitoring stations.

Table B2-1 gives the coefficient values that were estimated for the negative exponential relationship for each EC measurement station. These equations are similar to the RMA simulation results as well as the historical measurements for 1968-1991. A constant of 150 $\mu\text{S/cm}$ is assumed as the Sacramento River inflow EC. These equations can be used to estimate the effects of a change in outflow on EC at these locations. Because effective Delta outflow is a lagged moving average of monthly outflow values, a change in outflow caused by DW project operations may have a slight effect on EC values for more than one month.

These effective outflow equations summarize the historical EC measurements and the RMA simulation results. They are used for impact assessment in the same way that the hydraulic channel flow split equations were used to summarize the RMA hydrodynamic model results and to estimate the effects of DW operations on Delta channel flows. These summary relationships between EC and effective Delta outflow can be used to estimate EC under each DW project alternative for the entire 70-year hydrologic record (water years 1922-1991).

For example, Table B2-1 indicates that monthly average EC values ($\mu\text{S/cm}$) for Port Chicago (kilometer 63) can be reliably estimated from effective Delta outflow (cfs) as follows:

$$\text{Port Chicago EC} = 150 + 32,000 \cdot \exp(-0.00010 \cdot \text{effective outflow})$$

Similarly, EC values ($\mu\text{S/cm}$) for Chipps Island (kilometer 75) or Pittsburg (kilometer 77) can be reliably estimated from effective Delta outflow (cfs) as follows:

$$\text{Pittsburg EC} = 150 + 30,000 \cdot \exp(-0.00025 \cdot \text{effective outflow})$$

The negative exponent for Pittsburg is larger than for Port Chicago, so the effects of increasing effective outflow are stronger, and the salinity intrusion effects for a particular effective Delta outflow are reduced at Pittsburg compared with effects at Port Chicago. The EC at Collinsville (kilometer 84) can be reliably estimated as follows:

$$\text{Collinsville EC} = 150 + 25,000 \cdot \exp(-0.00030 \cdot \text{effective outflow})$$

Antioch (kilometer 89) EC can be estimated as follows:

$$\text{Antioch EC} = 150 + 20,000 \cdot \exp(-0.00035 \cdot \text{effective outflow})$$

Emmaton (kilometer 92) and Jersey Point (kilometer 100) EC have similar equations with approximately the same negative exponent, but because Emmaton is slightly downstream of Jersey Point, the effects of salinity intrusion are stronger at Emmaton during periods of low effective outflow:

$$\text{Emmaton EC} = 150 + 10,000 \cdot \exp(-0.00040 \cdot \text{effective outflow})$$

$$\text{Jersey EC} = 150 + 8,000 \cdot \exp(-0.00040 \cdot \text{effective outflow})$$

Rio Vista (kilometer 101) has a larger negative exponent, with greatly reduced magnitude of salinity intrusion episodes:

$$\text{Rio Vista} = 150 + 15,000 \\ \cdot \exp(-0.00080 \cdot \text{effective outflow})$$

Summary of Simulated Electrical Conductivity Values and Chloride Concentrations in Delta Exports

Delta export EC values are more strongly influenced than EC values at western Delta locations by San Joaquin River EC and by agricultural drainage flows and EC values. However, DW project effects on salinity at the export locations are calculated as the change from conditions under the No-Project Alternative. Because these influences from San Joaquin River EC and agricultural drainage EC would be the same under DW project operations and operations under the No-Project Alternative, impacts of the DW project on export salinity will be estimated from changes in effective Delta outflow.

The RMA simulation results for EC at Delta export locations (SWP and CVP pumping plants and CCWD diversion intake) varied slightly because of differences in estimated seawater intrusion and the varying contributions of San Joaquin River inflow and agricultural drainage at each location. However, the source contribution simulations, described in Appendix B1, "Hydrodynamic Modeling Methods and Results for the Delta Wetlands Project", indicated that the effects of DW project operations on source contributions at these export/diversion locations could be reliably estimated as a single representative value for the three locations using monthly inflows and exports, along with simulated DW project operations. The differences between the three locations were generally not large relative to the month-to-month differences caused by hydrologic variations in the inflow sources, periods of low effective outflow, and variations in agricultural drainage effects.

Cl⁻ concentrations at the Delta export locations are included as 1995 WQCP objectives. Elevated Cl⁻ concentrations at the export locations are largely dominated by seawater intrusion sources, although there is some Cl⁻ concentration in Sacramento and San Joaquin River inflows (see Appendix C1, "Analysis of Delta Inflow and Export Water Quality"). A background Cl⁻ concentration of 15 mg/l is assumed for impact assessment purposes. The ratio of Cl⁻ (mg/l) to EC (μS/cm) in seawater is approximately 1/3. The predicted seawater intrusion

concentration for export Cl⁻ is therefore one third of the predicted export EC value.

The historical EC and Cl⁻ measurements for the CCWD intake and EC for the CVP Tracy Pumping Plant suggest that the increased EC (μS/cm) and Cl⁻ concentration (mg/l) during periods of low Delta outflow can be reliably estimated as follows:

$$\text{Export EC} = 150 + 5,000 \\ \cdot \exp(-0.00050 \cdot \text{effective outflow})$$

$$\text{Export Cl}^- = 15 + 1,667 \\ \cdot \exp(-0.00050 \cdot \text{effective outflow})$$

The effects of DW discharges on Delta export water quality are calculated in the DeltaDWQ assessment model (described in Appendix C4) from the estimated DW discharge EC and the estimated source contribution from DW discharges (reducing the source contributions from other sources as described in Appendix B1). The slightly different Delta export EC and Cl⁻ concentration values obtained from the DeltaDWQ impact assessment model are reported in Chapter 3C for water quality impact assessment. However, the salinity intrusion effects resulting from hydrodynamic changes in Delta flows are accurately estimated with the equations given in this section.

Model uncertainties in monthly San Joaquin River EC values or monthly flow and EC values of Delta agricultural drainage discharges do not reduce the accuracy of the impact assessment results because the same estimates of San Joaquin River EC and agricultural drainage flow and EC values are used for each of the DW project alternatives.

IMPACT ASSESSMENT RESULTS FOR THE DW PROJECT ALTERNATIVES

General Approach

The water quality and fishery impact assessments (Chapters 3C and 3F, respectively) are based on simulations of Delta conditions under the 1995 WQCP objectives using Delta inflows, Delta exports, and DW project operations estimated with the Delta Standards and Operations Simulation model (DeltaSOS) based on DWRSIM results, as described in Appendices A1, "Delta Monthly Water Budgets for Operations Modeling of the Delta Wetlands Project", and A3, "DeltaSOS Simulations of the

Delta Wetlands Project Alternatives". Simulations of Delta hydrodynamics for historical conditions and operations of the DW project alternatives are described in Appendix B1, "Hydrodynamic Modeling Methods and Results for the Delta Wetlands Project".

The 1995 WQCP represents current Delta water quality objectives; therefore, estimates of inflows, exports, and outflows simulated for historical hydrologic conditions under the 1995 WQCP objectives differ from estimated historical values, which correspond to Delta conditions prior to establishment of current outflow requirements and export restrictions. Because the simulated Delta inflows, exports, and outflows associated with each DW alternative are different from historical inflows and exports, simulated seawater intrusion and salinity conditions for each DW project alternative are different from the observed EC patterns.

To provide the most appropriate comparison for determining DW project impacts, simulations of salinity for the DW project alternatives are referenced to simulations for the No-Project Alternative. The No-Project Alternative represents likely future operations on the DW islands (intensified agricultural use), without the DW project, under the 1995 WQCP objectives and with estimated export demands.

The following discussions summarize the results of simulations using the DeltaDWQ impact assessment model for EC at three selected locations and export Cl⁻ concentrations for the No-Project Alternative and the DW project alternatives. Simulated EC patterns are used as impact assessment response variables because they are regulated by water quality standards (such as those in the 1995 WQCP) or are directly related to potential water quality and fishery variables. Export Cl⁻ concentration, which is controlled by the 1995 WQCP objectives, can be estimated from salinity intrusion and source contributions and is directly proportional to concentration of Br⁻, an important variable for drinking water quality. EC patterns may influence the movement of larvae and juvenile stages of several important fish species and the distribution of estuarine species.

The selected locations are defined as follows:

- Chipps Island is the Delta outflow location, where Sacramento and San Joaquin River flows have combined and mixed.
- Emmaton is an important location for monitoring the effects of salinity intrusion on agricultural diversions upstream along the Sacramento

River channel. Emmaton is a salinity control point for the 1995 WQCP objectives.

- Jersey Point is the point of San Joaquin River outflow from the central Delta, where agricultural drainage and diversion flows from the Sacramento River have mixed with San Joaquin River flow. Jersey Point is a salinity control point for the 1995 WQCP objectives
- Delta export salinity is simulated as representative of the CCWD Rock Slough intake, SWP Banks Pumping Plant, and CVP Tracy Pumping Plant locations.

Simulation Results for the No-Project Alternative

Table B2-2 presents monthly simulated EC values for the four selected Delta locations for the 1968-1991 period for the No-Project Alternative. Monthly average Cl⁻ concentrations are also given for the representative Delta export location. The impact assessment for each DW alternative will be based on the calculated changes from these No-Project Alternative values. The No-Project Alternative values are sometimes considerably different from the measured historical values because the simulated Delta outflow sequence is very different from the historical Delta outflow for many months.

Because the measured historical EC values were accurately estimated from the effective Delta outflow relationships as described in the previous section, these estimates of EC and Cl⁻ for the No-Project Alternative are also considered to be a reliable basis for impact assessment for each DW project alternative.

Table B2-3 summarizes the changes shown in Table B2-2. The monthly changes are separated into EC increases (with percent increase) and EC decreases (with percent decrease). For example, the upper lefthand box of Table B2-3 indicates that DW Alternative 1 at Chipps Island changed the average EC value for the No-Project Alternative of 5,148 $\mu\text{S}/\text{cm}$ to 5,279 $\mu\text{S}/\text{cm}$. There were 138 months (out of 300) with a positive change in EC. The average increase in EC was 356 $\mu\text{S}/\text{cm}$ and the maximum increase was 3,804 $\mu\text{S}/\text{cm}$. The simulated increases in EC raised the EC values for the No-Project Alternative by an average of 12.9%, with a maximum change of 95.8%. There were 162 months with reduced EC values. The average reduction in EC was 11.6 $\mu\text{S}/\text{cm}$ with a maximum reduction of 99.6 $\mu\text{S}/\text{cm}$. The percentage change for the reductions averaged 0.3%. The maxi-

mun percentage change was 1.6%. Table B2-3 allows the monthly results to be summarized as months with increased salinity (potential impacts) and months with reduced salinity (potential benefits). All simulated changes in salinity are directly related to simulated changes in effective outflow that are the result of reduced agricultural diversions from the DW project islands, increased diversions for habitat islands, diversions for storage on the reservoir islands, or releases from the habitat islands. The largest changes in salinity are caused by storage diversions during months with moderate outflows.

Simulated Electrical Conductivity at Chipps Island

Figure B2-19 shows simulated patterns of monthly EC at Chipps Island for 1968-1991 for the No-Project Alternative. During periods of high Delta inflow, salinity at Chipps Island is flushed and becomes similar to river inflow salinity. During periods of low Delta inflow, outflow is often directly controlled by 1995 WQCP minimum Delta outflow requirements. The simulated average 1922-1991 EC value for the No-Project Alternative at Chipps Island was 5,148 $\mu\text{S}/\text{cm}$ (Table B2-3).

Simulated Electrical Conductivity at Emmaton

Figure B2-19 shows simulated patterns of monthly EC at Emmaton for 1968-1991 for the No-Project Alternative. EC is elevated less frequently at Emmaton than at Chipps Island because Emmaton is approximately 17 kilometers upstream, and much lower effective outflow will be required for seawater intrusion to reach Emmaton. During periods of low effective Delta outflow, the EC at Emmaton will remain considerably lower than EC at Chipps Island.

Simulated maximum EC values at Emmaton were generally lower than historical values at Emmaton because effective Delta outflows simulated for the No-Project Alternative were generally greater than historical outflows during periods of low historical Delta outflow that produced elevated Emmaton EC values. The average simulated EC at Emmaton for the 1922-1991 period was 1,050 $\mu\text{S}/\text{cm}$ for the No-Project Alternative (Table B2-3).

Simulated Electrical Conductivity at Jersey Point

Figure B2-19 shows simulated patterns of EC at Jersey Point for 1968-1991 for the No-Project Alternative. Simulated EC values for the No-Project Alternative

were generally lower than those for historical conditions at Jersey Point because the simulated outflows for the No-Project Alternative during low-flow periods were greater than historical outflows.

Seawater intrusion has much less effect at Jersey Point than at Chipps Island. Seawater intrusion was stronger during summers of a few years for the simulated No-Project Alternative because simulated Delta outflows were less than historical outflows. However, in most water years, simulated EC values for the No-Project Alternative were lower than simulated values for historical conditions during several months at the end of these water years. For such years, assumed Delta outflow values for the No-Project Alternative as simulated by DeltaSOS were greater than historical Delta outflows. The simulated average EC value for Jersey Point for 1922-1991 was 690 $\mu\text{S}/\text{cm}$ for the No-Project Alternative (Table B2-3).

Simulated Chloride Concentrations in Representative Delta Exports

Figure B2-20 shows the simulated pattern of monthly average Cl^- in representative Delta exports for the 1968-1991 period for the No-Project Alternative. As described in the previous section, seawater intrusion effects in the exports are similar to those observed at Jersey Point, but the Cl^- concentrations in the exports are reduced to about one third of those at Jersey Point by dilution in the Sacramento River diversions moving toward the export pumping plants (Denton 1993b).

Because Cl^- concentration (mg/l) is approximately one third of EC ($\mu\text{S}/\text{cm}$) in seawater, the resulting Cl^- concentration estimates for representative Delta exports were about 10% of the Jersey Point EC values. Historical Cl^- data for the CCWD intake indicate additional influences of San Joaquin River inflow, agricultural drainage, or temporary failure of the tidal gate on Sand Mound Slough. Because these other influences will not change with the DW project, these influences on Delta export Cl^- concentrations will not change the impact assessment results.

The average of simulated Cl^- concentrations in representative Delta exports for the 1922-1991 period for the No-Project Alternative was 75 mg/l. The 1995 WQCP objectives include a Cl^- concentration of less than 250 mg/l at all export locations, with some periods of 150 mg/l required during some water-year types. These export Cl^- concentrations are simulated indirectly in the DWRSIM model, using "carriage water" estimates (see "Carriage Water Calculations" in Appendix A2, "Delta-

SOS: Delta Standards and Operations Simulation Model"). The simulated Cl⁻ concentrations, calculated using the "negative exponential" estimates of historical EC and Cl⁻ data, were somewhat higher than 250 mg/l during some periods of low effective Delta outflow. Actual operations would, of course, protect CCWD exports, as required by the 1995 WQCP.

Simulation Results for Alternative 1

Alternative 1 involves potential year-round diversion and storage of surplus water on Bacon Island and Webb Tract (reservoir islands). Bouldin Island and Holland Tract (habitat islands) would be managed primarily as wildlife habitat.

Under Alternative 1, DW diversions could occur in any month with surplus flows. In DeltaSOS modeling, it is assumed that discharges of water from the DW project islands would be exported in any month when unused capacity within the permitted pumping rate exists at the SWP and CVP pumps and the 1995 WQCP "percent inflow" export limits do not prevent use of that capacity. Such unused capacity would exist when the amount of available water (i.e., total inflow less Delta channel depletion and Delta outflow requirements) is less than the amount specified by the export limits.

Water would be diverted to the reservoir islands (238-TAF water storage capacity) at a maximum average monthly diversion rate of 4,000 cfs, which would fill the two reservoir islands in one month. The maximum initial daily average diversion rate would be 9,000 cfs during several days when siphoning of water onto empty reservoirs begins; at this time, the maximum head differential would exist between island bottoms and channel water surfaces. The maximum initial daily average discharge rate would be 6,000 cfs, but the maximum monthly average discharge rate is assumed to be 4,000 cfs, allowing the two reservoir islands to empty in one month.

Chapter 2 presents a more complete description of DW project facilities and operations. Appendix A3 presents monthly average approximations of DW project operations under Alternative 1.

Table B2-2 gives monthly simulated changes in EC and Cl⁻ values for Alternative 1 compared with EC and Cl⁻ simulated for the No-Project Alternative. Mean EC and Cl⁻ values for Alternative 1 and the No-Project Alternative were very similar. Simulated effects of DW project operations on EC values were fairly small during

the diversion periods because the DW diversions generally were simulated to occur during months with high flows, corresponding to low EC values. However, some simulated DW diversions occurred in months with relatively low outflow requirements, so the potential change in EC and Cl⁻ was greater. Because DW discharge for export would not change Delta outflow, DW discharges would not affect EC values unless the DW discharge EC was different from the No-Project Alternative export EC.

Simulated Electrical Conductivity at Chipps Island and Emmaton

Figure B2-21 shows simulated EC values for Chipps Island and Emmaton for Alternative 1 and the changes from the No-Project Alternative conditions. Table B2-2 indicates that average EC at Chipps Island was 5,279 μ S/cm for Alternative 1, about 131 μ S/cm higher than for the No-Project Alternative. Average EC at Emmaton for Alternative 1 was 1,076 μ S/cm, about 26 μ S/cm higher than for the No-Project Alternative.

Simulated Electrical Conductivity at Jersey Point and Chloride Concentrations in Delta Exports

Figure B2-22 shows simulated EC values for Jersey Point for Alternative 1 and the changes from the No-Project Alternative. Table B2-2 indicates that average EC at Jersey Point was 705 μ S/cm for Alternative 1, only about 15 μ S/cm higher than for the No-Project Alternative.

Average Cl⁻ concentration in representative Delta exports for Alternative 1 was 77 mg/l, about 2 mg/l higher than for the No-Project Alternative.

Simulation Results for Alternative 2

Alternative 2 represents DW operations with two reservoir islands (Bacon Island and Webb Tract) and two habitat islands (Bouldin Island and Holland Tract). Chapter 2 provides a more complete description of Alternative 2.

Under Alternative 2, DW diversions could occur in any month with surplus flows, as under Alternative 1. In DeltaSOS modeling, it is assumed that discharges from the DW project islands would be exported in any month when unused capacity within the permitted pumping rate

exists at the SWP and CVP pumps. Under this alternative, export of DW discharges would be allowed in any month when such capacity exists and would not be constrained by the 1995 WQCP "percent inflow" export limits. Export of DW discharges would be limited by Delta outflow requirements and the permitted combined pumping rate of the export pumps but would not be subject to the "percent inflow" export limit.

The maximum monthly average diversion rate to reservoir island storage would be 4,000 cfs (maximum initial daily average diversion rate of 9,000 cfs). The maximum monthly average discharge rate is assumed to be 4,000 cfs (maximum initial daily average discharge rate of 6,000 cfs).

Table B2-2 gives monthly simulated changes in EC and Cl⁻ for Alternative 2 compared with EC and Cl⁻ simulated for the No-Project Alternative. DW project operation effects on EC values were quite small during the simulated diversion periods because DW diversions generally would occur during months with high flows, corresponding to low EC values. Because DW discharge for export would not change Delta outflow, DW discharges would not affect EC values unless the DW discharge EC was different from No-Project Alternative export EC.

Simulated Electrical Conductivity at Chipps Island and Emmaton

Figure B2-23 shows simulated EC values for Chipps Island and Emmaton for Alternative 2 and the changes from the No-Project Alternative conditions. Table B2-3 indicates that average EC at Chipps Island was 5,279 $\mu\text{S}/\text{cm}$ for Alternative 2, about 131 $\mu\text{S}/\text{cm}$ higher than for the No-Project Alternative. Average EC at Emmaton for Alternative 2 was 1,076 $\mu\text{S}/\text{cm}$, about 26 $\mu\text{S}/\text{cm}$ higher than for the No-Project Alternative.

Simulated Electrical Conductivity at Jersey Point and Chloride Concentrations in Delta Exports

Figure B2-24 shows simulated EC values for Jersey Point for Alternative 2 and the changes from the No-Project Alternative. Table B2-3 indicates that average EC at Jersey Point was 705 $\mu\text{S}/\text{cm}$ for Alternative 2, only about 15 $\mu\text{S}/\text{cm}$ higher than for the No-Project Alternative.

Average Cl⁻ concentration in representative Delta exports for Alternative 2 was 77 mg/l, about 2 mg/l higher than for the No-Project Alternative.

Simulation Results for Alternative 3

Alternative 3 involves storage of water on Bacon Island, Webb Tract, Bouldin Island, and Holland Tract, with secondary uses for wildlife habitat and recreation. The portion of Bouldin Island north of SR 12 would be managed as a wildlife habitat area and would not be used for water storage. Diversions to the reservoir islands (406-TAF capacity) would be allowed during any month with available surplus flows. The diversion and discharge operations for Alternative 3 would be the same as for Alternative 2, but the assumed diversion and discharge rates are higher. The maximum average monthly diversion rate would be about 7,000 cfs, which would fill the four reservoir islands in one month (maximum initial daily average diversion rate of 9,000 cfs). The maximum monthly discharge rate is assumed to be 4,000 cfs (maximum initial daily average discharge rate of 8,000 cfs). Chapter 2 provides a more complete description of Alternative 3.

Table B2-2 gives monthly simulated changes in EC and Cl⁻ values for Alternative 3 compared with EC and Cl⁻ simulated for the No-Project Alternative. Effects of Alternative 3 on EC values were quite small during simulated diversion periods because the DW diversions generally were simulated to occur during months with high flows, corresponding to low EC values. Because DW discharge for export would not change Delta outflow, DW discharges would not affect EC values.

Simulated Electrical Conductivity at Chipps Island and Emmaton

Figure B2-25 shows simulated EC values for Chipps Island and Emmaton for Alternative 3 and the changes from the No-Project Alternative. Table B2-3 indicates that average EC at Chipps Island was 5,324 $\mu\text{S}/\text{cm}$ for Alternative 3, about 177 $\mu\text{S}/\text{cm}$ higher than for the No-Project Alternative. Average EC at Emmaton for Alternative 3 was 1,082 $\mu\text{S}/\text{cm}$, about 31 $\mu\text{S}/\text{cm}$ higher than for the No-Project Alternative.

Simulated Electrical Conductivity at Jersey Point and Chloride Concentrations in Delta Exports

Figure B2-26 shows simulated EC values at Jersey Point for Alternative 3 and the changes from the No-Project Alternative. Table B2-3 indicates that average EC at Jersey Point was 709 $\mu\text{S}/\text{cm}$ for Alternative 3, about 19 $\mu\text{S}/\text{cm}$ higher than for the No-Project Alternative.

tive. Average Cl⁻ concentration in Delta exports for Alternative 3 was 77 mg/l, about 26 mg/l higher than for the No-Project Alternative.

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Personal Communications

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Table B2-1. Summary of EC Measurements and RMA Model Simulation Results

	Station										CCWD Rock Slough	CVP Tracy Pumping Plant	CCWD Chloride (mg/l)
	Benicia	Port Chicago	Chippis Island ¹	Pittsburg	Collinsville	Rio Vista	Antioch	Emmaton	Jersey Point				
Kilometer upstream	56	63	75	77	84	101	89	92	100				
Measured mean EC (1968-1991)	15,792	9,957	6,241	4,061	2,542	249	1,809	810	694	500	497	88	
Summary of RMA Results ($\mu\text{S}/\text{cm}$)													
RMA mean model EC (1968-1991)	14,604	9,540	7,049	3,309	2,421	191	1,509	532	547	292	369	45	
Difference	-1,188	-417	808	-752	-121	-59	-300	-278	-140	-208	-128	-43	
Standard deviation	3,050	2,337	2,471	1,777	1,190	95	1,123	585	564	210	150	59	
CV ² of differences	0.19	0.23	0.39	0.44	0.47	0.38	0.62	0.72	0.81	0.42	0.30	0.67	
Coefficient Values for the Negative Exponential Equation Relating EC and Effective Outflow: $EC = a + b \cdot \exp(\text{Outflow} \cdot c)$													
a	150	150	150	150	150	150	150	150	150	150	150	15	
b	33,000	32,000	30,000	30,000	25,000	15,000	20,000	10,000	8,000	5,000	5,000	1,667	
c	-0.00006	-0.00010	-0.00025	-0.00025	-0.00030	-0.00080	-0.00035	-0.00040	-0.00040	-0.00050	-0.00050	-0.00050	
Effective Outflow (cfs) Corresponding to Specified EC Values													
X2 (3 mS/cm)	60,000	25,000	10,000	9,000	7,500	2,000	5,500	3,000	2,500				
"Entrapment zone"													
(5mS/cm)	40,000	18,000	7,500	7,000	5,500	1,400	4,000	2,000	1,000				
(15mS/cm)	15,000	7,000	3,500	3,000	2,000	--	1,000	--	--				
Outflow model mean EC	17,006	10,783	-5,484	4,216	2,779	338	1,803	805	674	361	361	85	
Difference	1,259	866	-548	69	257	87	4	2	-11	-138	-131	-3	
Standard deviation	3,368	2,827	2,202	1,798	1,302	260	981	626	425	280	264	80	
CV ² of differences	0.21	0.28	0.35	0.44	0.51	1.00	0.54	0.77	0.61	0.56	0.53	0.91	

Notes: ¹ Data for 1976-1991.² Coefficient of variation = standard deviation/measured mean of difference.

Table B2-2. Monthly Simulated Effective Outflow (cfs), EC ($\mu\text{S}/\text{cm}$), and Export Chloride (mg/l) for the No-Project Alternative and Changes Resulting from Operations of the DW Alternatives for 1968-1991

Water Year	No-Project Alternative					Alternative 1 Changes					Alternative 2 Changes					Alternative 3 Changes				
	Effective Outflow	Chippis EC	Emmaton EC	Jersey EC	Export Cl ⁻	Effective Outflow	Chippis EC	Emmaton EC	Jersey EC	Export Cl ⁻	Effective Outflow	Chippis EC	Emmaton EC	Jersey EC	Export Cl ⁻	Effective Outflow	Chippis EC	Emmaton EC	Jersey EC	Export Cl ⁻
1968																				
OCT	13,816	1,257	175	165	17	(1,693)	583	33	20	2	(1,693)	583	33	20	2	(2,918)	1,188	82	49	6
NOV	8,358	4,482	533	380	41	(35)	39	7	4	0	(35)	39	7	4	0	(57)	62	11	7	1
DEC	7,021	6,200	897	598	65	(32)	49	12	7	1	(32)	49	12	7	1	(16)	25	6	4	0
JAN	17,910	548	153	152	15	(31)	3	0	0	0	(31)	3	0	0	0	(24)	2	0	0	0
FEB	59,217	150	150	150	15	(15)	0	0	0	0	(15)	0	0	0	0	(25)	0	0	0	0
MAR	29,161	174	150	150	15	25	(0)	(0)	(0)	(0)	25	(0)	(0)	(0)	(0)	(42)	0	0	0	0
APR	10,380	2,762	289	234	24	(0)	0	0	0	0	(0)	0	0	0	0	0	(0)	(0)	(0)	(0)
MAY	7,930	4,970	624	434	47	(0)	0	0	0	0	(0)	0	0	0	0	0	(0)	(0)	(0)	(0)
JUN	7,064	6,136	881	589	64	55	(82)	(20)	(12)	(1)	55	(82)	(20)	(12)	(1)	104	(154)	(37)	(22)	(2)
JUL	7,569	5,426	718	491	53	10	(13)	(3)	(2)	(0)	10	(13)	(3)	(2)	(0)	23	(30)	(6)	(4)	(0)
AUG	5,767	8,427	1,548	989	108	1	(2)	(1)	(0)	(0)	1	(2)	(1)	(0)	(0)	3	(6)	(2)	(1)	(0)
SEP	4,666	11,051	2,575	1,605	177	0	(1)	(0)	(0)	(0)	0	(1)	(0)	(0)	(0)	1	(2)	(1)	(0)	(0)
1969																				
OCT	4,964	10,269	2,240	1,404	154	0	(0)	(0)	(0)	(0)	0	(0)	(0)	(0)	(0)	0	(1)	(0)	(0)	(0)
NOV	5,411	9,197	1,821	1,152	126	0	(0)	(0)	(0)	(0)	0	(0)	(0)	(0)	(0)	0	(0)	(0)	(0)	(0)
DEC	11,083	2,342	248	209	22	(2,573)	1,978	257	154	17	(2,573)	1,978	257	154	17	(3,639)	3,252	507	304	34
JAN	105,340	150	150	150	15	(8,228)	0	0	0	0	(8,228)	0	0	0	0	(14,013)	0	0	0	0
FEB	129,847	150	150	150	15	(7)	0	0	0	0	(7)	0	0	0	0	(20)	0	0	0	0
MAR	51,928	150	150	150	15	25	(0)	(0)	(0)	(0)	25	(0)	(0)	(0)	(0)	(42)	0	0	0	0
APR	44,212	151	150	150	15	(25)	0	0	0	0	(25)	0	0	0	0	(77)	0	0	0	0
MAY	55,817	150	150	150	15	(39)	0	0	0	0	(39)	0	0	0	0	(97)	0	0	0	0
JUN	25,197	214	150	150	15	(49)	1	0	0	0	(49)	1	0	0	0	(104)	2	0	0	0
JUL	8,113	4,754	583	410	44	1	(1)	(0)	(0)	(0)	1	(1)	(0)	(0)	(0)	2	(2)	(0)	(0)	(0)
AUG	6,209	7,562	1,271	823	90	0	(0)	(0)	(0)	(0)	0	(0)	(0)	(0)	(0)	0	(0)	(0)	(0)	(0)
SEP	11,302	2,225	238	203	21	(2,826)	2,131	273	164	18	(2,826)	2,131	273	164	18	(4,218)	3,881	636	382	42
1970																				
OCT	17,016	647	155	153	15	(1,076)	153	4	2	0	(1,076)	153	4	2	0	(2,557)	445	13	8	1
NOV	10,907	2,440	257	214	22	(29)	17	2	1	0	(29)	17	2	1	0	(21)	12	1	1	0
DEC	46,466	150	150	150	15	(60)	0	0	0	0	(60)	0	0	0	0	(31)	0	0	0	0
JAN	197,156	150	150	150	15	(0)	0	0	0	0	(0)	0	0	0	0	(11)	0	0	0	0
FEB	83,351	150	150	150	15	(7)	0	0	0	0	(7)	0	0	0	0	(20)	0	0	0	0
MAR	30,331	168	150	150	15	25	(0)	(0)	(0)	(0)	25	(0)	(0)	(0)	(0)	(42)	0	0	0	0
APR	11,623	2,065	225	195	20	(0)	0	0	0	0	(0)	0	0	0	0	0	(0)	(0)	(0)	(0)
MAY	7,975	4,917	614	428	46	(0)	0	0	0	0	(0)	0	0	0	0	6	(8)	(1)	(1)	(0)
JUN	7,660	5,307	693	476	51	55	(70)	(15)	(9)	(1)	55	(70)	(15)	(9)	(1)	106	(135)	(28)	(17)	(2)
JUL	8,998	3,841	428	317	34	9	(8)	(1)	(1)	(0)	9	(8)	(1)	(1)	(0)	23	(21)	(3)	(2)	(0)
AUG	6,280	7,432	1,232	799	87	1	(1)	(0)	(0)	(0)	1	(1)	(0)	(0)	(0)	1	(2)	(1)	(0)	(0)
SEP	4,558	11,350	2,710	1,886	186	0	(0)	(0)	(0)	(0)	0	(0)	(0)	(0)	(0)	0	(1)	(0)	(0)	(0)

Table B2-2. Continued

Water Year	No-Project Alternative					Alternative 1 Changes					Alternative 2 Changes					Alternative 3 Changes				
	Effective Outflow	Chipps EC	Emmaton EC	Jersey EC	Export CI ⁻	Effective Outflow	Chipps EC	Emmaton EC	Jersey EC	Export CI ⁻	Effective Outflow	Chipps EC	Emmaton EC	Jersey EC	Export CI ⁻	Effective Outflow	Chipps EC	Emmaton EC	Jersey EC	Export CI ⁻
1971																				
OCT	4,860	10,535	2,351	1,471	162	0	(0)	(0)	(0)	(0)	0	(0)	(0)	(0)	(0)	0	(0)	(0)	(0)	(0)
NOV	11,338	2,206	236	202	21	(2,494)	1,779	214	128	14	(2,494)	1,779	214	128	14	(3,711)	3,144	466	279	31
DEC	58,991	150	150	150	15	(4,014)	0	0	0	0	(4,014)	0	0	0	0	(7,499)	0	0	0	0
JAN	45,818	150	150	150	15	0	(0)	(0)	(0)	(0)	0	(0)	(0)	(0)	(0)	(11)	0	0	0	0
FEB	22,777	268	150	150	15	(0)	0	0	0	0	(0)	0	0	0	0	0	(0)	(0)	(0)	(0)
MAR	43,558	151	150	150	15	(3,104)	1	0	0	0	(2,310)	1	0	0	0	(2,387)	1	0	0	0
APR	16,283	747	157	154	15	3	(0)	(0)	(0)	(0)	2	(0)	(0)	(0)	(0)	2	(0)	(0)	(0)	(0)
MAY	25,445	210	150	150	15	(182)	3	0	0	0	(156)	2	0	0	0	(261)	4	0	0	0
JUN	12,768	1,588	192	175	18	70	(25)	(1)	(1)	(0)	70	(25)	(1)	(1)	(0)	133	(47)	(3)	(2)	(0)
JUL	9,714	3,236	344	267	28	(5)	4	0	0	0	(5)	4	0	0	0	(3)	2	0	0	0
AUG	6,310	7,377	1,216	789	86	(0)	0	0	0	0	(0)	0	0	0	0	(0)	0	0	0	0
SEP	6,117	7,735	1,324	855	93	(0)	0	0	0	0	(0)	0	0	0	0	(0)	0	0	0	0
1972																				
OCT	7,640	5,333	698	479	52	(1,737)	2,818	758	455	51	(1,737)	2,818	758	455	51	(1,701)	2,747	735	441	49
NOV	6,736	6,648	1,012	667	72	(429)	736	206	124	14	(429)	736	206	124	14	(417)	714	200	120	13
DEC	10,987	2,395	253	212	22	(1,437)	970	108	65	7	(1,437)	970	108	65	7	(3,270)	2,839	425	255	28
JAN	9,468	3,431	370	282	30	(332)	284	40	24	3	(214)	180	25	15	2	(591)	523	76	45	5
FEB	16,899	662	155	153	15	(125)	16	0	0	0	(72)	9	0	0	0	(232)	31	1	0	0
MAR	22,432	278	150	150	15	(12)	0	0	0	0	(919)	33	0	0	0	(948)	34	0	0	0
APR	9,953	3,057	322	253	26	0	(0)	(0)	(0)	(0)	16	(12)	(1)	(1)	(0)	17	(12)	(1)	(1)	(0)
MAY	7,903	5,003	631	438	47	0	(0)	(0)	(0)	(0)	1	(1)	(0)	(0)	(0)	1	(1)	(0)	(0)	(0)
JUN	7,060	6,142	883	590	64	55	(82)	(20)	(12)	(1)	55	(82)	(20)	(12)	(1)	104	(154)	(37)	(22)	(2)
JUL	7,656	5,312	694	476	51	9	(12)	(3)	(2)	(0)	9	(12)	(3)	(2)	(0)	23	(29)	(6)	(4)	(0)
AUG	7,006	6,224	903	602	65	(3)	5	1	1	0	(3)	5	1	1	0	(1)	1	0	0	0
SEP	4,583	11,280	2,678	1,667	184	(0)	1	0	0	0	(0)	1	0	0	0	(0)	0	0	0	0
1973																				
OCT	5,204	9,679	2,003	1,262	139	(0)	0	0	0	0	(0)	0	0	0	0	(0)	0	0	0	0
NOV	11,639	2,057	224	195	20	(2,595)	1,741	197	118	13	(2,595)	1,741	197	118	13	(3,669)	2,865	390	234	28
DEC	18,295	511	153	152	15	(943)	96	2	1	0	(943)	96	2	1	0	(2,397)	296	6	4	0
JAN	71,002	150	150	150	15	(564)	0	0	0	0	(404)	0	0	0	0	(1,053)	0	0	0	0
FEB	89,977	150	150	150	15	(7)	0	0	0	0	(7)	0	0	0	0	(20)	0	0	0	0
MAR	55,634	150	150	150	15	25	(0)	(0)	(0)	(0)	25	(0)	(0)	(0)	(0)	(42)	0	0	0	0
APR	15,007	972	164	158	16	50	(10)	(0)	(0)	(0)	50	(10)	(0)	(0)	(0)	74	(15)	(1)	(0)	(0)
MAY	14,164	1,165	171	163	16	59	(15)	(1)	(0)	(0)	59	(15)	(1)	(0)	(0)	99	(25)	(1)	(1)	(0)
JUN	10,528	2,668	279	228	24	1	(0)	(0)	(0)	(0)	1	(0)	(0)	(0)	(0)	1	(1)	(0)	(0)	(0)
JUL	9,514	3,394	365	279	29	0	(0)	(0)	(0)	(0)	0	(0)	(0)	(0)	(0)	0	(0)	(0)	(0)	(0)
AUG	5,930	8,097	1,439	923	101	0	(0)	(0)	(0)	(0)	0	(0)	(0)	(0)	(0)	0	(0)	(0)	(0)	(0)
SEP	4,692	10,981	2,544	1,587	175	0	(0)	(0)	(0)	(0)	0	(0)	(0)	(0)	(0)	0	(0)	(0)	(0)	(0)

Table B2-2. Continued

Water Year	No-Project Alternative						Alternative 1 Changes						Alternative 2 Changes						Alternative 3 Changes					
	Effective Outflow	Chippis EC	Emmation EC	Jersey EC	Export CI-		Effective Outflow	Chippis EC	Emmation EC	Jersey EC	Export CI-		Effective Outflow	Chippis EC	Emmation EC	Jersey EC	Export CI-		Effective Outflow	Chippis EC	Emmation EC	Jersey EC	Export CI-	
1974																								
OCT	5,254	9,561	1,958	1,235	136		0	(0)	(0)	(0)	(0)		0	(0)	(0)	(0)	(0)		0	(0)	(0)	(0)	(0)	
NOV	40,244	151	150	150	15		(2,609)	1	0	0	0		(3,882)	2	0	0	0		(819)	0	0	0	0	
DEC	65,172	150	150	150	15		(41)	0	0	0	0		(11)	0	0	0	0		(20)	0	0	0	0	
JAN	125,805	150	150	150	15		0	0	0	0	0		(42)	0	0	0	0		(77)	0	0	0	0	
FEB	38,960	152	150	150	15		(7)	0	0	0	0		(25)	0	0	0	0		(42)	0	0	0	0	
MAR	103,030	150	150	150	15		24	(0)	0	0	0		(77)	0	0	0	0		(101)	(6)	(0)	(0)	(0)	
APR	68,918	150	150	150	15		(25)	0	0	0	0		(25)	0	0	0	0		128	(47)	(3)	(2)	(0)	
MAY	19,915	391	151	151	15		60	(4)	(0)	(0)	(0)		60	(4)	(0)	(0)	(0)		1	(1)	(0)	(0)	(0)	
JUN	12,594	1,652	196	178	18		67	(25)	(2)	(1)	(0)		67	(25)	(2)	(1)	(0)							
JUL	8,372	4,466	530	378	40		0	(0)	(0)	(0)	(0)		0	(0)	(0)	(0)	(0)							
AUG	6,234	7,516	1,257	814	89		0	(0)	(0)	(0)	(0)		0	(0)	(0)	(0)	(0)							
SEP	8,425	4,410	520	372	40		(2,120)	2,977	699	419	47		(2,120)	2,977	699	419	47		(2,120)	2,977	699	419	47	
1975																								
OCT	11,706	2,026	222	193	20		(1,739)	1,017	99	59	7		(1,739)	1,017	99	59	7		(3,663)	2,810	376	226	25	
NOV	8,964	3,872	433	320	34		(147)	139	22	13	1		(147)	139	22	13	1		(434)	426	68	41	5	
DEC	8,836	3,993	451	331	35		(53)	51	8	5	1		(53)	51	8	5	1		(86)	83	13	8	1	
JAN	6,949	6,311	925	615	67		(20)	0	0	0	0		(18)	27	7	4	0		(18)	27	7	4	0	
FEB	47,585	150	150	150	15		(20)	0	0	0	0		(67)	0	0	0	0		(42)	0	0	0	0	
MAR	81,701	150	150	150	15		25	(0)	0	0	0		(42)	0	0	0	0		74	(4)	(0)	(0)	(0)	
APR	19,925	390	151	151	15		50	(3)	(0)	(0)	(0)		50	(3)	(0)	(0)	(0)		(236)	2	0	0	0	
MAY	27,523	186	150	150	15		(108)	1	0	0	0		(108)	1	0	0	0		(132)	(25)	(1)	(0)	(0)	
JUN	15,295	915	162	157	16		69	(13)	(0)	(0)	(0)		69	(13)	(0)	(0)	(0)		(3)	3	0	0	0	
JUL	8,593	4,234	490	354	38		(1)	1	0	0	0		(1)	1	0	0	0		(0)	0	0	0	0	
AUG	6,252	7,482	1,247	808	88		(0)	0	0	0	0		(0)	0	0	0	0		(0)	0	0	0	0	
SEP	6,730	6,658	1,014	669	73		(506)	878	249	149	17		(506)	878	249	149	17		(506)	878	249	149	17	
1976																								
OCT	11,600	2,076	226	195	20		(2,623)	1,784	205	123	14		(2,623)	1,784	205	123	14		(4,135)	3,489	523	314	35	
NOV	11,195	2,281	243	206	21		(436)	245	23	14	2		(1,343)	850	89	53	6		(28)	45	11	7	1	
DEC	6,871	6,432	955	633	69		(4)	6	0	1	0		(6)	11	3	2	0		(2)	11	(3)	(2)	(0)	
JAN	6,120	7,730	1,322	853	93		(1)	1	0	0	0		(13)	1	0	0	0		(21)	(3)	(5)	(3)	(0)	
FEB	9,332	3,545	385	291	31		(16)	(13)	(2)	(1)	(0)		(50)	(6)	(4)	(4)	(0)		51	(39)	(5)	(3)	(0)	
MAR	9,680	3,262	348	269	28		65	(50)	(6)	(4)	(0)		(50)	(6)	(4)	(4)	(0)		4	(5)	(1)	(1)	(0)	
APR	7,793	5,138	658	455	49		5	(6)	(1)	(1)	(0)		(1)	(1)	(0)	(0)	(0)		1	(151)	(39)	(23)	(3)	
MAY	6,666	6,761	1,042	685	74		1	(1)	(0)	(0)	(0)		(79)	(20)	(12)	(12)	(1)		96	(36)	(11)	(7)	(1)	
JUN	6,836	6,486	969	642	70		50	(79)	(6)	(4)	(0)		50	(79)	(6)	(4)	(0)		19	(36)	(11)	(7)	(1)	
JUL	6,027	7,907	1,378	887	97		10	(19)	(2)	(1)	(0)		10	(19)	(2)	(1)	(0)		3	(6)	(4)	(2)	(0)	
AUG	4,197	12,406	3,215	1,989	219		1	(4)	(2)	(1)	(0)		1	(4)	(2)	(1)	(0)							
SEP	3,522	14,661	4,447	2,728	302		0	(2)	(1)	(1)	(0)		0	(2)	(1)	(1)	(0)							

Table B2-2. Continued

Water Year	No-Project Alternative					Alternative 1 Changes					Alternative 2 Changes					Alternative 3 Changes				
	Effective Outflow	Chippis EC	Emmaton EC	Jersey EC	Export CI ⁻	Effective Outflow	Chippis EC	Emmaton EC	Jersey EC	Export CI ⁻	Effective Outflow	Chippis EC	Emmaton EC	Jersey EC	Export CI ⁻	Effective Outflow	Chippis EC	Emmaton EC	Jersey EC	Export CI ⁻
1977	16	(24)	(6)	(4)	(0)		2	(3)	(1)	(1)	(0)									
OCT	3,254	15,666	5,063	3,098	343	0	(1)	(1)	(0)	(0)	0	(1)	(1)	(0)	(0)	0	(2)	(1)	(1)	(0)
NOV	4,190	12,428	3,227	1,996	220	0	(0)	(0)	(0)	(0)	0	(0)	(0)	(0)	(0)	0	(1)	(0)	(0)	(0)
DEC	5,890	8,177	1,465	939	103	0	(0)	(0)	(0)	(0)	0	(0)	(0)	(0)	(0)	0	(0)	(0)	(0)	(0)
JAN	4,931	10,351	2,274	1,424	157	0	(0)	(0)	(0)	(0)	0	(0)	(0)	(0)	(0)	0	(0)	(0)	(0)	(0)
FEB	6,908	6,374	941	624	68	0	(0)	(0)	(0)	(0)	0	(0)	(0)	(0)	(0)	0	(0)	(0)	(0)	(0)
MAR	6,900	6,387	944	626	68	16	(24)	(6)	(4)	(0)	16	(24)	(6)	(4)	(0)	2	(3)	(1)	(1)	(0)
APR	6,898	6,390	945	627	68	4	(6)	(2)	(1)	(0)	4	(6)	(2)	(1)	(0)	1	(1)	(0)	(0)	(0)
MAY	5,107	9,912	2,095	1,317	145	1	(1)	(1)	(0)	(0)	1	(1)	(1)	(0)	(0)	0	(0)	(0)	(0)	(0)
JUN	4,399	11,804	2,922	1,813	200	0	(0)	(0)	(0)	(0)	0	(0)	(0)	(0)	(0)	0	(0)	(0)	(0)	(0)
JUL	4,166	12,502	3,264	2,018	223	0	(0)	(0)	(0)	(0)	0	(0)	(0)	(0)	(0)	0	(0)	(0)	(0)	(0)
AUG	3,741	13,886	4,000	2,460	272	0	(0)	(0)	(0)	(0)	0	(0)	(0)	(0)	(0)	0	(0)	(0)	(0)	(0)
SEP	3,355	15,279	4,821	2,953	326	0	(0)	(0)	(0)	(0)	0	(0)	(0)	(0)	(0)	0	(0)	(0)	(0)	(0)
1978	25	(0)	(0)	(0)	(0)		(42)	0	0	0	0									
OCT	3,178	15,965	5,254	3,213	355	0	(0)	(0)	(0)	(0)	0	(0)	(0)	(0)	(0)	0	(0)	(0)	(0)	(0)
NOV	3,347	15,310	4,841	2,964	328	0	(0)	(0)	(0)	(0)	0	(0)	(0)	(0)	(0)	0	(0)	(0)	(0)	(0)
DEC	5,047	10,060	2,154	1,352	149	0	(0)	(0)	(0)	(0)	0	(0)	(0)	(0)	(0)	0	(0)	(0)	(0)	(0)
JAN	38,413	152	150	150	15	(2,451)	2	0	0	0	(2,451)	2	0	0	0	(3,802)	4	0	0	0
FEB	53,369	150	150	150	15	(13)	0	0	0	0	(13)	0	0	0	0	(698)	0	0	0	0
MAR	61,156	150	150	150	15	25	(0)	(0)	(0)	(0)	25	(0)	(0)	(0)	(0)	(42)	0	0	0	0
APR	36,875	153	150	150	15	(25)	0	0	0	0	(25)	0	0	0	0	(77)	0	0	0	0
MAY	15,862	814	159	155	16	60	(10)	(0)	(0)	(0)	60	(10)	(0)	(0)	(0)	101	(17)	(0)	(0)	(0)
JUN	9,071	3,774	418	311	33	(1)	1	0	0	0	(1)	1	0	0	0	(2)	2	0	0	0
JUL	8,176	4,683	569	402	43	(0)	0	0	0	0	(0)	0	0	0	0	(0)	0	0	0	0
AUG	5,862	8,233	1,483	950	104	(0)	0	0	0	0	(0)	0	0	0	0	(0)	0	0	0	0
SEP	5,424	9,170	1,810	1,146	126	(0)	0	0	0	0	(0)	0	0	0	0	(0)	0	0	0	0
1979	25	(0)	(0)	(0)	(0)		(40)	1	0	0	0									
OCT	7,858	5,058	642	445	48	(2,005)	3,195	848	509	57	(2,005)	3,195	848	509	57	(1,972)	3,127	826	498	55
NOV	6,799	6,546	985	651	71	(626)	1,084	307	184	20	(626)	1,084	307	184	20	(615)	1,063	301	180	20
DEC	5,450	9,111	1,789	1,133	124	(120)	273	101	61	7	(120)	273	101	61	7	(118)	267	99	60	7
JAN	15,311	912	162	157	16	(2,691)	731	34	20	2	(2,691)	731	34	20	2	(4,082)	1,352	79	48	5
FEB	38,456	152	150	150	15	(1,032)	1	0	0	0	(1,032)	1	0	0	0	(2,481)	2	0	0	0
MAR	26,115	201	150	150	15	25	(0)	(0)	(0)	(0)	25	(0)	(0)	(0)	(0)	(40)	1	0	0	0
APR	14,455	1,093	168	161	16	50	(12)	(0)	(0)	(0)	50	(12)	(0)	(0)	(0)	74	(17)	(1)	(0)	(0)
MAY	12,491	1,691	198	179	18	59	(22)	(1)	(1)	(0)	59	(22)	(1)	(1)	(0)	98	(37)	(2)	(1)	(0)
JUN	11,014	2,379	251	211	22	3	(2)	(0)	(0)	(0)	3	(2)	(0)	(0)	(0)	5	(3)	(0)	(0)	(0)
JUL	7,003	6,227	904	602	65	0	(0)	(0)	(0)	(0)	0	(0)	(0)	(0)	(0)	0	(0)	(0)	(0)	(0)
AUG	5,243	9,585	1,967	1,240	136	0	(0)	(0)	(0)	(0)	0	(0)	(0)	(0)	(0)	0	(0)	(0)	(0)	(0)
SEP	4,044	12,885	3,460	2,136	236	0	(0)	(0)	(0)	(0)	0	(0)	(0)	(0)	(0)	0	(0)	(0)	(0)	(0)

Table B2-2. Continued

Water Year	No-Project Alternative					Alternative 1 Changes					Alternative 2 Changes					Alternative 3 Changes				
	Effective Outflow	Chippis EC	Emmaton EC	Jersey EC	Export CI ⁺	Effective Outflow	Chippis EC	Emmaton EC	Jersey EC	Export CI ⁺	Effective Outflow	Chippis EC	Emmaton EC	Jersey EC	Export CI ⁺	Effective Outflow	Chippis EC	Emmaton EC	Jersey EC	Export CI ⁺
1980																				
OCT	4,020	12,961	3,499	2,160	238	0	(0)	(0)	(0)	(0)	0	(0)	(0)	(0)	(0)	0	(0)	(0)	(0)	(0)
NOV	7,107	6,071	865	579	63	(1,630)	2,979	901	541	60	(1,630)	2,979	901	541	60	(1,607)	2,927	882	529	59
DEC	10,949	2,416	255	213	22	(1,722)	1,220	143	86	10	(1,722)	1,220	143	86	10	(3,513)	3,188	502	301	33
JAN	96,644	150	150	150	15	(4,727)	0	0	0	0	(4,719)	0	0	0	0	(11,816)	0	0	0	0
FEB	127,706	150	150	150	15	(7)	0	0	0	0	(7)	0	0	0	0	(19)	0	0	0	0
MAR	63,895	150	150	150	15	25	(0)	(0)	(0)	(0)	25	(0)	(0)	(0)	(0)	(42)	0	0	0	0
APR	15,046	964	164	158	16	50	(10)	(0)	(0)	(0)	50	(10)	(0)	(0)	(0)	74	(15)	(0)	(0)	(0)
MAY	12,392	1,730	201	181	18	58	(23)	(1)	(1)	(0)	58	(23)	(1)	(1)	(0)	98	(38)	(2)	(1)	(0)
JUN	7,983	4,907	612	427	46	0	(0)	(0)	(0)	(0)	0	(0)	(0)	(0)	(0)	0	(0)	(0)	(0)	(0)
JUL	7,998	4,889	608	425	46	0	(0)	(0)	(0)	(0)	0	(0)	(0)	(0)	(0)	0	(0)	(0)	(0)	(0)
AUG	5,847	8,265	1,494	956	105	0	(0)	(0)	(0)	(0)	0	(0)	(0)	(0)	(0)	0	(0)	(0)	(0)	(0)
SEP	5,564	8,860	1,698	1,079	118	0	(0)	(0)	(0)	(0)	0	(0)	(0)	(0)	(0)	0	(0)	(0)	(0)	(0)
1981																				
OCT	7,791	5,140	658	455	49	(1,931)	3,097	826	496	55	(1,931)	3,097	826	496	55	(1,897)	3,028	804	482	54
NOV	6,426	7,171	1,156	754	82	(426)	790	239	143	16	(426)	790	239	143	16	(416)	769	232	139	15
DEC	7,022	6,199	897	598	65	(1,001)	1,719	485	291	32	(1,001)	1,719	485	291	32	(1,079)	1,873	534	320	36
JAN	15,348	905	162	157	16	(901)	191	7	4	0	(901)	191	7	4	0	(2,781)	758	35	21	2
FEB	20,361	365	151	151	15	(76)	4	0	0	0	(76)	4	0	0	0	(369)	21	0	0	0
MAR	25,477	210	150	150	15	(6)	0	0	0	0	(615)	10	0	0	0	(718)	12	0	0	0
APR	12,304	1,765	203	182	19	0	(0)	(0)	(0)	(0)	6	(3)	(0)	(0)	(0)	7	(3)	(0)	(0)	(0)
MAY	7,982	4,908	612	427	46	0	(0)	(0)	(0)	(0)	0	(0)	(0)	(0)	(0)	0	(0)	(0)	(0)	(0)
JUN	6,495	7,050	1,122	733	80	55	(94)	(26)	(16)	(2)	55	(94)	(26)	(16)	(2)	105	(178)	(50)	(30)	(3)
JUL	6,934	6,334	930	618	67	11	(17)	(4)	(3)	(0)	11	(17)	(4)	(3)	(0)	26	(39)	(10)	(6)	(1)
AUG	5,356	9,323	1,867	1,180	129	2	(4)	(1)	(1)	(0)	2	(4)	(1)	(1)	(0)	4	(8)	(3)	(2)	(0)
SEP	4,131	12,612	3,319	2,052	226	0	(1)	(1)	(0)	(0)	0	(1)	(1)	(0)	(0)	1	(2)	(1)	(1)	(0)
1982																				
OCT	4,503	11,504	2,781	1,729	190	0	(0)	(0)	(0)	(0)	0	(0)	(0)	(0)	(0)	0	(1)	(1)	(0)	(0)
NOV	17,638	576	154	152	15	(2,381)	346	8	5	1	(2,381)	346	8	5	1	(3,543)	607	18	11	1
DEC	85,974	150	150	150	15	(1,407)	0	0	0	0	(1,407)	0	0	0	0	(3,104)	0	0	0	0
JAN	77,881	150	150	150	15	(352)	0	0	0	0	(123)	0	0	0	0	(135)	0	0	0	0
FEB	94,845	150	150	150	15	(7)	0	0	0	0	(7)	0	0	0	0	(20)	0	0	0	0
MAR	79,101	150	150	150	15	25	(0)	0	(0)	0	25	(0)	0	(0)	0	(42)	0	0	0	0
APR	139,945	150	150	150	15	(25)	0	0	0	0	(25)	0	0	0	0	(77)	0	0	0	0
MAY	46,703	150	150	150	15	(39)	0	0	0	0	(39)	0	0	0	0	(97)	0	0	0	0
JUN	16,998	650	155	153	15	32	(4)	(0)	(0)	(0)	32	(4)	(0)	(0)	(0)	95	(12)	(0)	(0)	(0)
JUL	8,302	4,542	544	386	41	(1)	1	0	0	0	(1)	1	0	0	0	(3)	3	0	0	0
AUG	6,276	7,438	1,234	800	87	(0)	0	0	0	0	(0)	0	0	0	0	(0)	0	0	0	0
SEP	13,292	1,412	182	169	17	(2,842)	1,306	102	61	7	(2,842)	1,306	102	61	7	(4,241)	2,381	238	143	16

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Table B2-2. Continued

Water Year	No-Project Alternative					Alternative 1 Changes					Alternative 2 Changes					Alternative 3 Changes				
	Effective Outflow	Chipps EC	Emmaton EC	Jersey EC	Export CI ⁻	Effective Outflow	Chipps EC	Emmaton EC	Jersey EC	Export CI ⁻	Effective Outflow	Chipps EC	Emmaton EC	Jersey EC	Export CI ⁻	Effective Outflow	Chipps EC	Emmaton EC	Jersey EC	Export CI ⁻
1983																				
OCT	29,889	170	150	150	15	(1,363)	8	0	0	0	(1,363)	8	0	0	0	(2,945)	22	0	0	0
NOV	43,749	151	150	150	15	(52)	0	0	0	0	(52)	0	0	0	0	(62)	0	0	0	0
DEC	86,205	150	150	150	15	(34)	0	0	0	0	(34)	0	0	0	0	(11)	0	0	0	0
JAN	101,369	150	150	150	15	0	(0)	0	0	0	0	(0)	0	0	0	(11)	0	0	0	0
FEB	181,018	150	150	150	15	(7)	0	0	0	0	(7)	0	0	0	0	(20)	0	0	0	0
MAR	256,037	150	150	150	15	25	0	0	0	0	25	0	0	0	0	(42)	0	0	0	0
APR	105,749	150	150	150	15	(25)	0	0	0	0	(25)	0	0	0	0	(77)	0	0	0	0
MAY	78,406	150	150	150	15	(39)	0	0	0	0	(39)	0	0	0	0	(97)	0	0	0	0
JUN	70,952	150	150	150	15	(49)	0	0	0	0	(49)	0	0	0	0	(104)	0	0	0	0
JUL	28,552	178	150	150	15	(52)	0	0	0	0	(52)	0	0	0	0	(110)	1	0	0	0
AUG	8,682	4,144	478	345	37	(54)	55	9	5	1	(54)	55	9	5	1	(114)	115	19	11	1
SEP	20,592	353	151	151	15	(89)	5	0	0	0	(89)	5	0	0	0	(166)	9	0	0	0
1984																				
OCT	32,998	159	150	150	15	(67)	0	0	0	0	(67)	0	0	0	0	(74)	0	0	0	0
NOV	76,960	150	150	150	15	(38)	0	0	0	0	(38)	0	0	0	0	(21)	0	0	0	0
DEC	152,708	150	150	150	15	(34)	0	0	0	0	(34)	0	0	0	0	(11)	0	0	0	0
JAN	75,962	150	150	150	15	0	(0)	0	0	0	0	(0)	0	0	0	(11)	0	0	0	0
FEB	41,156	151	150	150	15	(7)	0	0	0	0	(7)	0	0	0	0	(19)	0	0	0	0
MAR	30,795	166	150	150	15	25	(0)	(0)	(0)	(0)	25	(0)	(0)	(0)	(0)	(42)	0	0	0	0
APR	12,661	1,627	195	177	18	50	(18)	(1)	(1)	(0)	50	(18)	(1)	(1)	(0)	74	(27)	(2)	(1)	(0)
MAY	9,241	3,623	396	298	31	57	(49)	(7)	(4)	(0)	57	(49)	(7)	(4)	(0)	95	(81)	(11)	(7)	(1)
JUN	8,391	4,446	527	376	40	65	(70)	(12)	(7)	(1)	65	(70)	(12)	(7)	(1)	123	(130)	(22)	(13)	(1)
JUL	8,760	4,067	463	338	36	13	(13)	(2)	(1)	(0)	13	(13)	(2)	(1)	(0)	24	(24)	(4)	(2)	(0)
AUG	6,265	7,460	1,240	804	88	1	(2)	(0)	(0)	(0)	1	(2)	(0)	(0)	(0)	2	(3)	(1)	(1)	(0)
SEP	5,817	8,325	1,514	968	106	0	(0)	(0)	(0)	(0)	0	(0)	(0)	(0)	(0)	0	(1)	(0)	(0)	(0)
1985																				
OCT	8,376	4,462	529	378	40	(2,082)	2,945	695	417	46	(2,082)	2,945	695	417	46	(2,047)	2,882	677	408	45
NOV	25,347	212	150	150	15	(3,268)	78	0	0	0	(3,268)	78	0	0	0	(5,230)	167	1	1	0
DEC	20,077	381	151	151	15	(43)	2	0	0	0	(43)	2	0	0	0	(43)	3	0	0	0
JAN	6,873	6,429	955	633	69	16	(25)	(6)	(4)	(0)	16	(25)	(6)	(4)	(0)	19	(30)	(8)	(5)	(1)
FEB	13,170	1,451	185	171	17	28	(9)	(0)	(0)	(0)	28	(9)	(0)	(0)	(0)	44	(14)	(1)	(0)	(0)
MAR	14,054	1,193	172	163	16	70	(18)	(1)	(0)	(0)	70	(18)	(1)	(0)	(0)	55	(14)	(1)	(0)	(0)
APR	8,235	4,616	557	394	42	(1)	1	0	0	0	(1)	1	0	0	0	(1)	1	0	0	0
MAY	9,670	3,270	349	269	28	(0)	0	0	0	0	(0)	0	0	0	0	(0)	0	0	0	0
JUN	6,831	6,819	1,058	695	76	59	(98)	(26)	(16)	(2)	59	(98)	(26)	(16)	(2)	112	(185)	(50)	(30)	(3)
JUL	7,028	6,189	894	597	65	11	(17)	(4)	(3)	(0)	11	(17)	(4)	(3)	(0)	26	(40)	(10)	(6)	(1)
AUG	6,106	7,754	1,330	858	94	2	(4)	(1)	(1)	(0)	2	(4)	(1)	(1)	(0)	5	(9)	(3)	(2)	(0)
SEP	4,450	11,654	2,851	1,771	195	0	(1)	(0)	(0)	(0)	0	(1)	(0)	(0)	(0)	1	(2)	(1)	(1)	(0)

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Table B2-2. Continued

Water Year	No - Project Alternative					Alternative 1 Changes					Alternative 2 Changes					Alternative 3 Changes				
	Effective Outflow	Chipps EC	Emmaton EC	Jersey EC	Export CI ⁻	Effective Outflow	Chipps EC	Emmaton EC	Jersey EC	Export CI ⁻	Effective Outflow	Chipps EC	Emmaton EC	Jersey EC	Export CI ⁻	Effective Outflow	Chipps EC	Emmaton EC	Jersey EC	Export CI ⁻
1986																				
OCT	4,583	11,280	2,678	1,667	184	0	(0)	(0)	(0)	(0)	0	(0)	(0)	(0)	(0)	0	(1)	(0)	(0)	(0)
NOV	4,950	10,305	2,255	1,413	155	0	(0)	(0)	(0)	(0)	0	(0)	(0)	(0)	(0)	0	(0)	(0)	(0)	(0)
DEC	6,330	7,341	1,205	783	85	(254)	472	143	86	10	(254)	472	143	86	10	(254)	472	143	86	10
JAN	9,858	3,127	331	259	27	(1,890)	1,798	284	171	19	(1,890)	1,798	284	171	19	(1,887)	1,795	284	170	19
FEB	190,644	150	150	150	15	(14,711)	0	0	0	0	(14,711)	0	0	0	0	(17,093)	0	0	0	0
MAR	149,241	150	150	150	15	25	0	0	0	0	25	0	0	0	0	(42)	0	0	0	0
APR	28,310	180	150	150	15	(25)	0	0	0	0	(25)	0	0	0	0	(77)	1	0	0	0
MAY	11,409	2,170	233	200	21	60	(30)	(2)	(1)	(0)	60	(30)	(2)	(1)	(0)	101	(51)	(4)	(2)	(0)
JUN	7,970	4,922	615	429	46	63	(75)	(15)	(9)	(1)	63	(75)	(15)	(9)	(1)	120	(142)	(27)	(16)	(2)
JUL	7,996	4,892	609	425	46	13	(15)	(3)	(2)	(0)	13	(15)	(3)	(2)	(0)	24	(28)	(5)	(3)	(0)
AUG	6,197	7,585	1,278	827	90	1	(3)	(1)	(0)	(0)	1	(3)	(1)	(0)	(0)	3	(5)	(1)	(1)	(0)
SEP	4,662	11,061	2,580	1,608	177	0	(1)	(0)	(0)	(0)	0	(1)	(0)	(0)	(0)	0	(1)	(1)	(0)	(0)
1987																				
OCT	4,537	11,409	2,737	1,702	187	(6)	16	8	5	1	(6)	16	8	5	1	25	(70)	(32)	(19)	(2)
NOV	5,144	9,824	2,060	1,296	142	(3)	7	3	2	0	(3)	7	3	2	0	12	(29)	(11)	(7)	(1)
DEC	4,793	10,710	2,426	1,516	167	(1)	2	1	1	0	(1)	2	1	1	0	4	(10)	(4)	(3)	(0)
JAN	5,394	9,238	1,836	1,161	127	(0)	1	0	0	0	(0)	1	0	0	0	2	(4)	(1)	(1)	(0)
FEB	9,980	3,037	320	252	26	15	(11)	(1)	(1)	(0)	15	(11)	(1)	(1)	(0)	29	(21)	(2)	(1)	(0)
MAR	22,185	287	150	150	15	(885)	34	0	0	0	(885)	34	0	0	0	(894)	34	0	0	0
APR	10,612	2,616	274	224	23	14	(9)	(1)	(1)	(0)	14	(9)	(1)	(1)	(0)	14	(9)	(1)	(1)	(0)
MAY	7,942	4,956	621	433	46	1	(1)	(0)	(0)	(0)	1	(1)	(0)	(0)	(0)	1	(1)	(0)	(0)	(0)
JUN	6,490	7,059	1,124	734	80	55	(94)	(26)	(16)	(2)	55	(94)	(26)	(16)	(2)	105	(178)	(50)	(30)	(3)
JUL	7,015	6,209	899	600	65	12	(18)	(4)	(3)	(0)	12	(18)	(4)	(3)	(0)	27	(41)	(10)	(6)	(1)
AUG	5,804	8,352	1,523	974	107	2	(4)	(1)	(1)	(0)	2	(4)	(1)	(1)	(0)	4	(9)	(3)	(2)	(0)
SEP	4,232	12,300	3,163	1,958	216	0	(1)	(1)	(0)	(0)	0	(1)	(1)	(0)	(0)	1	(2)	(1)	(1)	(0)
1988																				
OCT	4,100	12,708	3,368	2,081	230	0	(0)	(0)	(0)	(0)	0	(0)	(0)	(0)	(0)	0	(1)	(0)	(0)	(0)
NOV	4,458	11,632	2,841	1,764	194	0	(0)	(0)	(0)	(0)	0	(0)	(0)	(0)	(0)	0	(0)	(0)	(0)	(0)
DEC	5,922	8,114	1,444	927	101	(36)	73	24	14	2	(36)	73	24	14	2	(36)	73	24	14	2
JAN	14,277	1,136	170	162	16	(2,688)	945	56	34	4	(2,688)	945	56	34	4	(4,177)	1,816	140	84	9
FEB	11,566	2,092	227	196	20	(135)	67	5	3	0	(135)	67	5	3	0	(311)	157	13	8	1
MAR	8,176	4,683	569	402	43	62	(70)	(13)	(8)	(1)	62	(70)	(13)	(8)	(1)	40	(46)	(8)	(5)	(1)
APR	7,471	5,557	747	508	55	10	(13)	(3)	(2)	(0)	10	(13)	(3)	(2)	(0)	6	(9)	(2)	(1)	(0)
MAY	6,715	6,682	1,021	672	73	2	(3)	(1)	(0)	(0)	2	(3)	(1)	(0)	(0)	1	(2)	(1)	(0)	(0)
JUN	6,849	6,465	964	638	69	51	(80)	(20)	(12)	(1)	51	(80)	(20)	(12)	(1)	97	(151)	(38)	(23)	(3)
JUL	5,836	8,286	1,501	961	105	9	(19)	(6)	(4)	(0)	9	(19)	(6)	(4)	(0)	17	(35)	(12)	(7)	(1)
AUG	4,169	12,495	3,260	2,016	222	1	(5)	(2)	(1)	(0)	1	(5)	(2)	(1)	(0)	3	(9)	(4)	(3)	(0)
SEP	3,512	14,696	4,468	2,741	303	0	(2)	(1)	(1)	(0)	0	(2)	(1)	(1)	(0)	1	(3)	(2)	(1)	(0)

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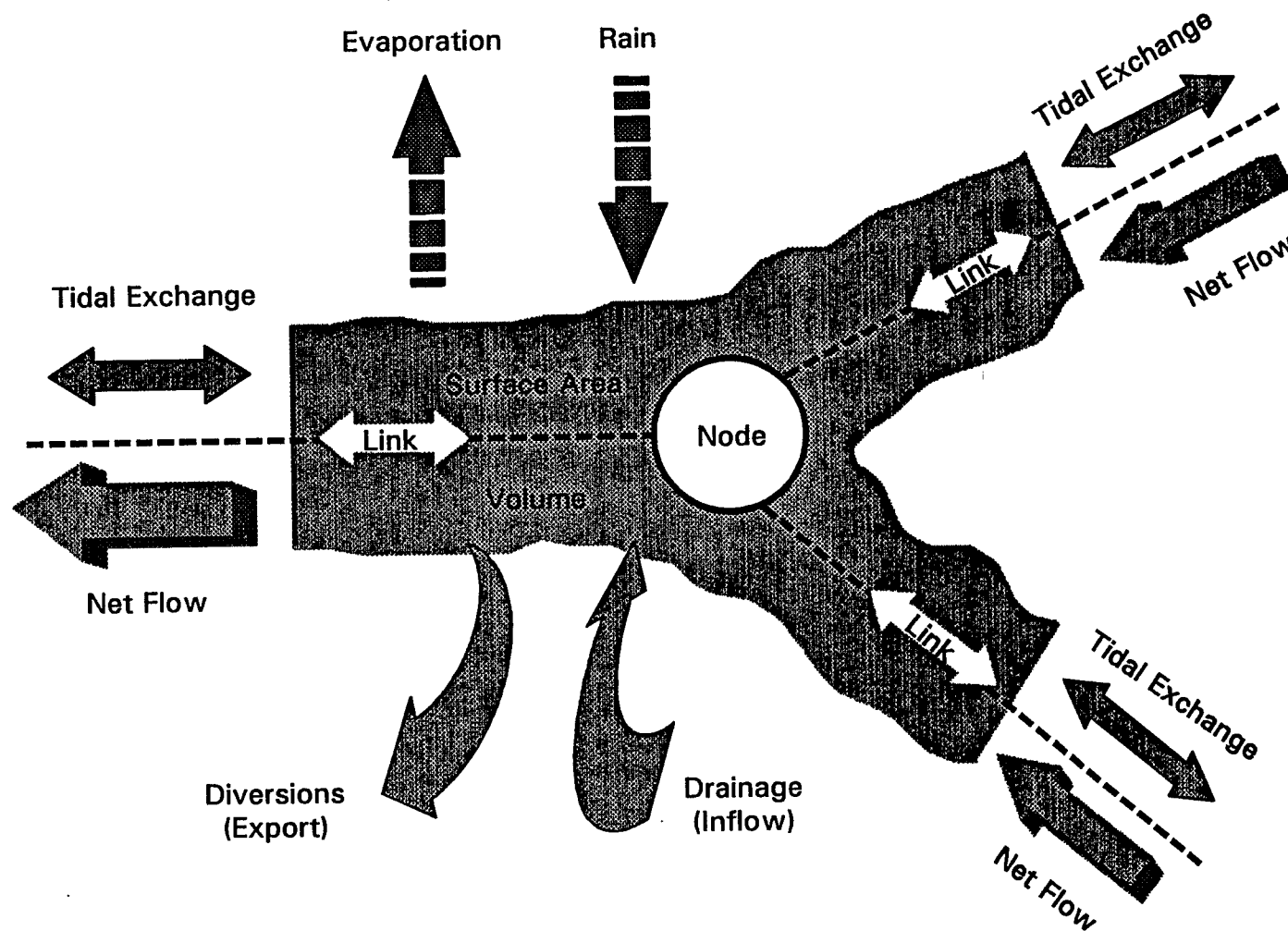
Table B2-2. Continued

		No-Project Alternative					Alternative 1 Changes					Alternative 2 Changes					Alternative 3 Changes				
Water Year	Effective Outflow	Chippis EC	Emmation EC	Jersey EC	Export CI-	Effective Outflow	Chippis EC	Emmation EC	Jersey EC	Export CI-	Effective Outflow	Chippis EC	Emmation EC	Jersey EC	Export CI-	Effective Outflow	Chippis EC	Emmation EC	Jersey EC	Export CI-	
1989																					
OCT	3,250	15,682	5,074	3,104	343	0	(1)	(1)	(0)	(0)	0	(1)	(1)	(0)	(0)	0	(2)	(1)	(1)	(0)	
NOV	3,918	13,293	3,675	2,265	250	0	(0)	(0)	(0)	(0)	0	(0)	(0)	(0)	(0)	0	(1)	(0)	(0)	(0)	
DEC	4,813	10,658	2,404	1,502	165	0	(0)	(0)	(0)	(0)	0	(0)	(0)	(0)	(0)	0	(0)	(0)	(0)	(0)	
JAN	5,416	9,188	1,817	1,150	126	0	(0)	(0)	(0)	(0)	0	(0)	(0)	(0)	(0)	0	(0)	(0)	(0)	(0)	
FEB	7,241	5,876	819	551	60	16	(22)	(5)	(3)	(0)	16	(22)	(5)	(3)	(0)	27	(39)	(9)	(5)	(1)	
MAR	25,740	206	150	150	15	(2,809)	57	0	0	0	(2,809)	57	0	0	0	(2,808)	57	0	0	0	
APR	17,822	556	153	152	15	56	(6)	(0)	(0)	(0)	56	(6)	(0)	(0)	(0)	80	(8)	(0)	(0)	(0)	
MAY	10,482	2,697	282	229	24	(1)	1	0	0	0	(1)	1	0	0	0	(1)	1	0	0	0	
JUN	6,654	6,782	1,048	689	75	61	(100)	(27)	(16)	(2)	61	(100)	(27)	(16)	(2)	115	(188)	(50)	(30)	(9)	
JUL	7,109	6,069	865	579	63	12	(18)	(4)	(3)	(0)	12	(18)	(4)	(3)	(0)	28	(41)	(10)	(6)	(1)	
AUG	6,364	7,281	1,188	773	84	(3)	5	2	1	0	(3)	5	2	1	0	(0)	0	0	0	0	
SEP	4,531	11,425	2,744	1,707	188	(0)	1	1	0	0	(0)	1	1	0	0	(0)	0	0	0	0	
1990																					
OCT	4,215	12,352	3,188	1,973	218	(0)	0	0	0	0	(0)	0	0	0	0	(0)	0	0	0	0	
NOV	4,380	11,860	2,948	1,829	202	(0)	0	0	0	0	(0)	0	0	0	0	(0)	0	0	0	0	
DEC	5,568	8,850	1,695	1,077	118	(0)	0	0	0	0	(0)	0	0	0	0	(0)	0	0	0	0	
JAN	7,133	6,033	856	574	62	(655)	1,047	23	164	18	(655)	1,047	23	164	18	(653)	1,043	273	164	18	
FEB	10,376	2,765	290	234	24	(306)	208	(60)	(12)	2	(306)	208	(60)	(12)	2	(291)	198	22	13	1	
MAR	7,695	5,262	683	470	51	47	(60)	(12)	(7)	(1)	47	(60)	(12)	(7)	(1)	32	(41)	(9)	(5)	(1)	
APR	9,703	3,245	345	267	28	15	(12)	(1)	(0)	(0)	15	(12)	(1)	(0)	(0)	10	(8)	(1)	(1)	(1)	
MAY	6,455	7,120	1,142	745	81	1	(1)	(0)	(0)	(0)	1	(1)	(0)	(0)	(0)	0	(1)	(0)	(0)	(0)	
JUN	6,775	6,583	995	657	71	50	(79)	(21)	(12)	(1)	50	(79)	(21)	(12)	(1)	95	(151)	(39)	(23)	(3)	
JUL	5,891	8,175	1,464	939	103	10	(19)	(6)	(4)	(0)	10	(19)	(6)	(4)	(0)	18	(36)	(12)	(7)	(1)	
AUG	4,199	12,400	3,212	1,987	219	2	(5)	(2)	(1)	(0)	2	(5)	(2)	(1)	(0)	3	(9)	(4)	(3)	(0)	
SEP	3,522	14,659	4,446	2,728	301	0	(2)	(1)	(1)	(0)	0	(2)	(1)	(1)	(0)	1	(3)	(2)	(1)	(1)	
1991																					
OCT	3,254	15,665	5,062	3,097	343	0	(1)	(1)	(0)	(0)	0	(1)	(1)	(0)	(0)	0	(2)	(1)	(1)	(1)	
NOV	3,700	14,027	4,080	2,508	277	0	(0)	(0)	(0)	(0)	0	(0)	(0)	(0)	(0)	0	(1)	(1)	(0)	(0)	
DEC	4,135	12,598	3,312	2,047	226	0	(0)	(0)	(0)	(0)	0	(0)	(0)	(0)	(0)	0	(0)	(0)	(0)	(0)	
JAN	4,636	11,133	2,612	1,627	179	0	(0)	(0)	(0)	(0)	0	(0)	(0)	(0)	(0)	0	(0)	(0)	(0)	(0)	
FEB	6,825	6,504	974	644	70	0	(0)	(0)	(0)	(0)	0	(0)	(0)	(0)	(0)	0	(0)	(0)	(0)	(0)	
MAR	17,624	577	154	152	15	7	(1)	(0)	(0)	(0)	7	(1)	(0)	(0)	(0)	(6)	1	0	0	0	
APR	11,447	2,151	232	199	20	(0)	0	0	0	0	(0)	0	0	0	0	0	(0)	(0)	(0)	(0)	
MAY	5,979	8,001	1,408	905	99	0	(0)	(0)	(0)	(0)	0	(0)	(0)	(0)	(0)	33	(59)	(14)	(8)	(1)	
JUN	6,717	6,678	1,020	672	73	0	(0)	(0)	(0)	(0)	0	(0)	(0)	(0)	(0)	4	(11)	(5)	(3)	(0)	
JUL	4,868	10,514	2,342	1,465	161	0	(0)	(0)	(0)	(0)	0	(0)	(0)	(0)	(0)	1	(4)	(2)	(1)	(1)	
AUG	3,964	13,143	3,595	2,217	245	0	(0)	(0)	(0)	(0)	0	(0)	(0)	(0)	(0)	0	(2)	(1)	(1)	(0)	
SEP	3,441	14,958	4,625	2,835	313	0	(0)	(0)	(0)	(0)	0	(0)	(0)	(0)	(0)	0	(2)	(1)	(1)	(0)	

Note: Negative values shown in parentheses.

Table B2-3. Summary of DeltaDWQ-Simulated Changes in EC ($\mu\text{S/cm}$) and Export Chloride (mg/l) from the No-Project Alternative Resulting from DW Project Alternatives for 1967-1991

<div>Alternative 1</div> <div>Chipps Island EC (μS/cm)</div> <div>No-Project Average5,148</div> <div>Alt. 1 Average5,279</div> <div>Alt. 1 Average Change131</div>					<div>Alternative 2</div> <div>Chipps Island EC (μS/cm)</div> <div>No-Project Average5,148</div> <div>Alt. 2 Average5,279</div> <div>Alt. 2 Average Change131</div>					<div>Alternative 3</div> <div>Chipps Island EC (μS/cm)</div> <div>No-Project Average5,148</div> <div>Alt. 3 Average5,324</div> <div>Alt. 3 Average Change177</div>				
<div>Changes in EC</div> <div>x>0% x<=0%</div> <div>Months (#)138162</div> <div>Maximum3,80495.80.00.0</div> <div>Average35612.9-11.6-0.3</div> <div>Minimum0.00.0-99.6-1.6</div>					<div>Changes in EC</div> <div>x>0% x<=0%</div> <div>Months (#)138162</div> <div>Maximum3,80495.80.00.0</div> <div>Average35613.0-11.7-0.3</div> <div>Minimum0.00.0-99.6-1.6</div>					<div>Changes in EC</div> <div>x>0% x<=0%</div> <div>Months (#)146154</div> <div>Maximum3,8811740.00.0</div> <div>Average46520.3-22.0-0.5</div> <div>Minimum0.00.0-188-3.0</div>				
<div>Alternative 1</div> <div>Emmaton EC (μS/cm)</div> <div>No-Project Average1,050</div> <div>Alt. 1 Average1,076</div> <div>Alt. 1 Average Change26</div>					<div>Alternative 2</div> <div>Emmaton EC (μS/cm)</div> <div>No-Project Average1,050</div> <div>Alt. 2 Average1,076</div> <div>Alt. 2 Average Change26</div>					<div>Alternative 3</div> <div>Emmaton EC (μS/cm)</div> <div>No-Project Average1,050</div> <div>Alt. 3 Average1,082</div> <div>Alt. 3 Average Change31</div>				
<div>Changes in EC</div> <div>x>0% x<=0%</div> <div>Months (#)124176</div> <div>Maximum9011980.00.0</div> <div>Average79.416.5-2.3-0.3</div> <div>Minimum0.00.0-26.8-2.6</div>					<div>Changes in EC</div> <div>x>0% x<=0%</div> <div>Months (#)123177</div> <div>Maximum9011980.00.0</div> <div>Average80.016.6-2.3-0.3</div> <div>Minimum0.00.0-26.8-2.6</div>					<div>Changes in EC</div> <div>x>0% x<=0%</div> <div>Months (#)128172</div> <div>Maximum8822670.00.0</div> <div>Average98.725.6-4.5-0.5</div> <div>Minimum0.00.0-50.2-4.8</div>				
<div>Alternative 1</div> <div>Jersey EC (μS/cm)</div> <div>No-Project Average690</div> <div>Alt. 1 Average705</div> <div>Alt. 1 Average Change15</div>					<div>Alternative 2</div> <div>Jersey EC (μS/cm)</div> <div>No-Project Average690</div> <div>Alt. 2 Average705</div> <div>Alt. 2 Average Change15</div>					<div>Alternative 3</div> <div>Jersey EC (μS/cm)</div> <div>No-Project Average690</div> <div>Alt. 3 Average709</div> <div>Alt. 3 Average Change19</div>				
<div>Changes in EC</div> <div>x>0% x<=0%</div> <div>Months (#)124176</div> <div>Maximum5411620.00.0</div> <div>Average47.713.0-1.4-0.3</div> <div>Minimum0.00.0-16.1-2.3</div>					<div>Changes in EC</div> <div>x>0% x<=0%</div> <div>Months (#)124176</div> <div>Maximum5411620.00.0</div> <div>Average47.613.0-1.4-0.3</div> <div>Minimum0.00.0-16.1-2.3</div>					<div>Changes in EC</div> <div>x>0% x<=0%</div> <div>Months (#)127173</div> <div>Maximum5291880.00.0</div> <div>Average59.719.4-2.7-0.5</div> <div>Minimum0.00.0-30.1-4.4</div>				
<div>Alternative 1</div> <div>Export Chloride (mg/l)</div> <div>No-Project Average75</div> <div>Alt. 1 Average77</div> <div>Alt. 1 Average Change2</div>					<div>Alternative 2</div> <div>Export Chloride (mg/l)</div> <div>No-Project Average75</div> <div>Alt. 2 Average77</div> <div>Alt. 2 Average Change2</div>					<div>Alternative 3</div> <div>Export Chloride (mg/l)</div> <div>No-Project Average75</div> <div>Alt. 3 Average77</div> <div>Alt. 3 Average Change2</div>				
<div>Changes in EC</div> <div>x>0% x<=0%</div> <div>Months (#)125175</div> <div>Maximum60.11700.00.0</div> <div>Average5.313.6-0.2-0.3</div> <div>Minimum0.00.0-1.8-2.4</div>					<div>Changes in EC</div> <div>x>0% x<=0%</div> <div>Months (#)124176</div> <div>Maximum60.11700.00.0</div> <div>Average5.313.7-0.2-0.3</div> <div>Minimum0.00.0-1.8-2.4</div>					<div>Changes in EC</div> <div>x>0% x<=0%</div> <div>Months (#)126174</div> <div>Maximum58.82030.00.0</div> <div>Average6.720.8-0.3-0.5</div> <div>Minimum0.00.0-3.3-4.5</div>				



Note: Water quality mass balance will track flow • concentration terms.

Figure B2-1.
Diagram of Mass-Balance Terms for the RMA Delta Model

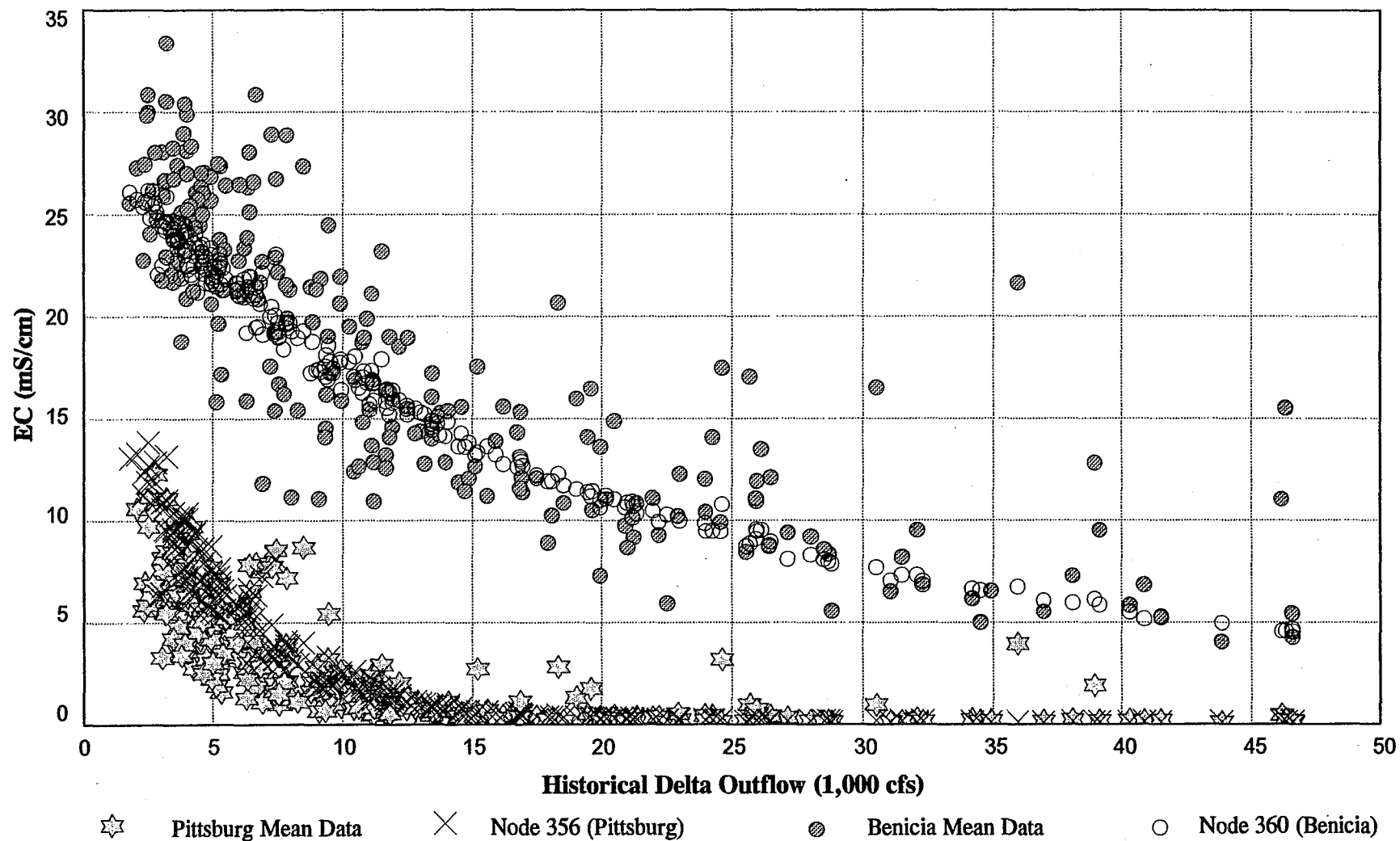


Figure B2-2.
Relationship between Simulated End-of-Month and Measured Mean Monthly EC
and Historical Delta Outflow at Pittsburg and Benicia for 1968-1991

DELTA WETLANDS
PROJECT EIR/EIS
Prepared by: Jones & Stokes Associates

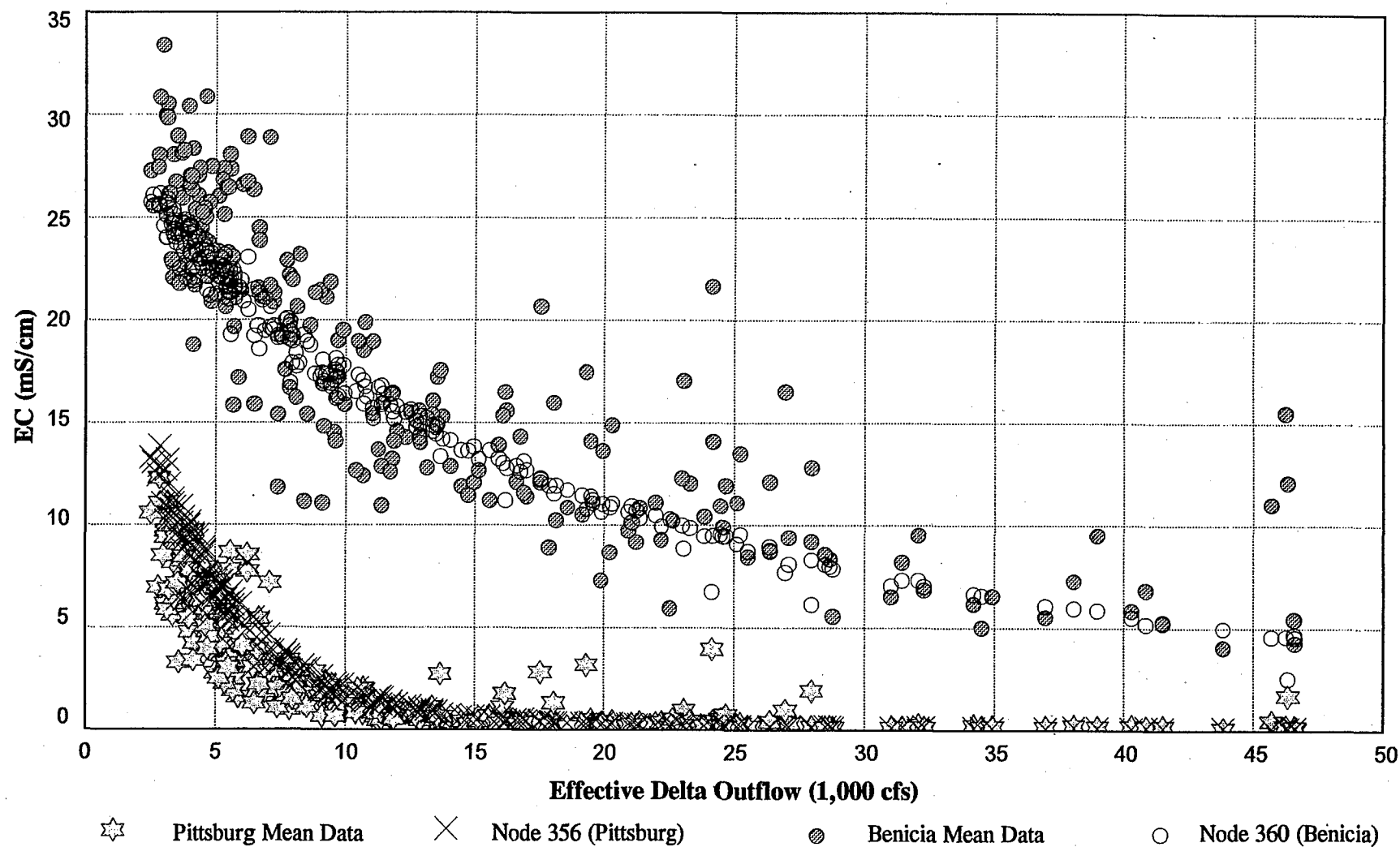


Figure B2-3.
Relationship between Simulated End-of-Month and Measured Mean Monthly EC
and Effective Delta Outflow at Pittsburg and Benicia for 1968-1991

DELTA WETLANDS
PROJECT EIR/EIS
Prepared by: Jones & Stokes Associates

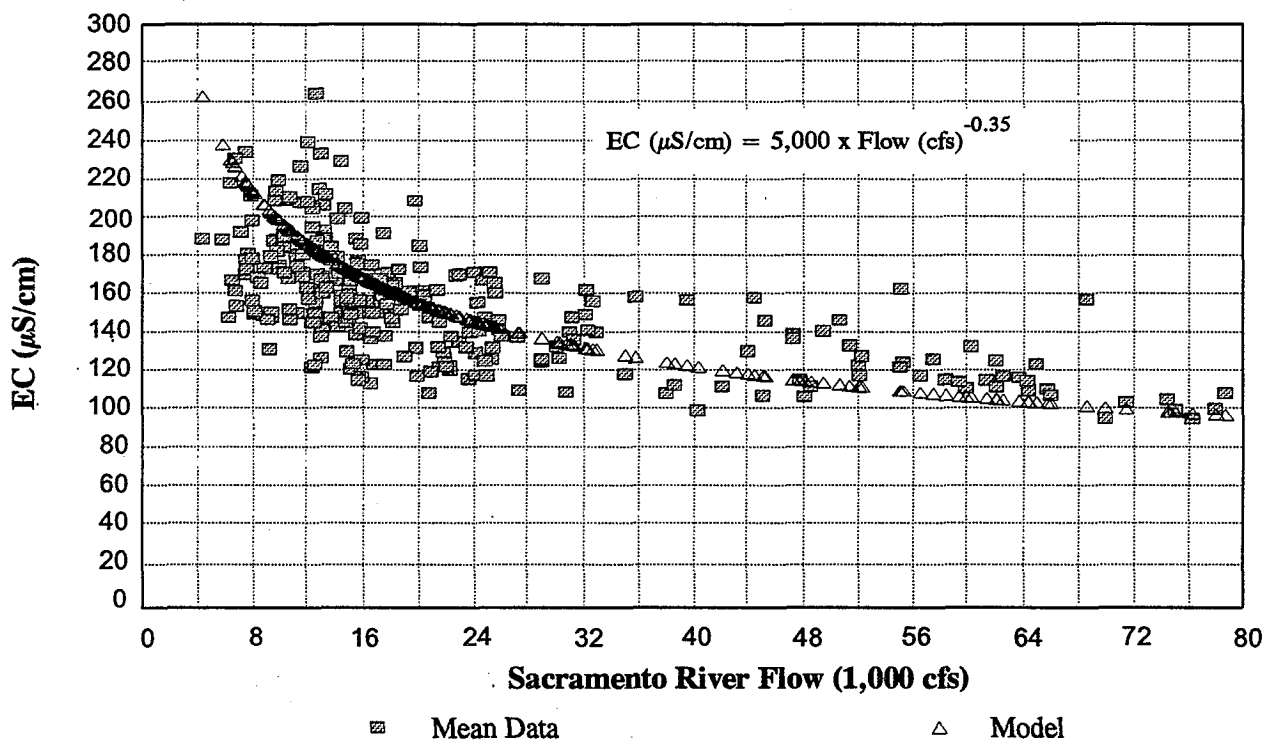
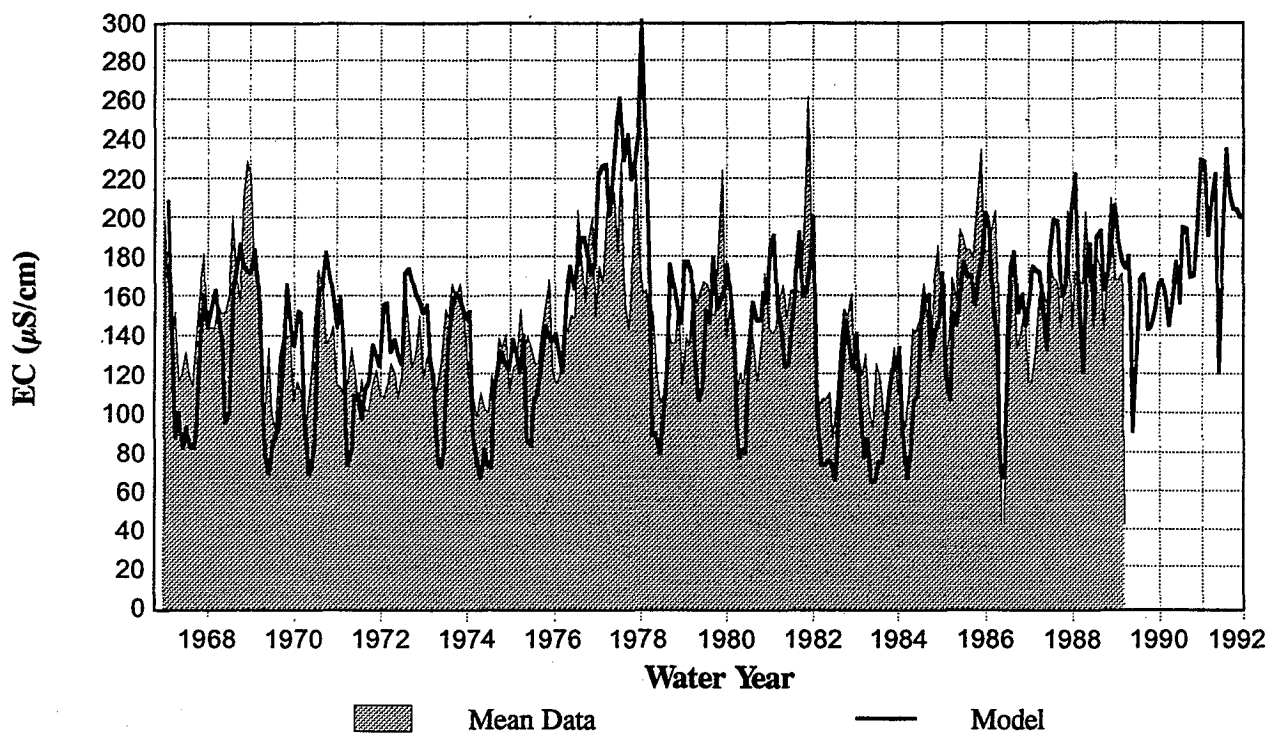


Figure B2-4.
Relationship between Simulated End-of-Month and Measured Mean Monthly EC at Greene's Landing and Sacramento River Flow for 1967-1991

DELTA WETLANDS
PROJECT EIR/EIS
Prepared by: Jones & Stokes Associates

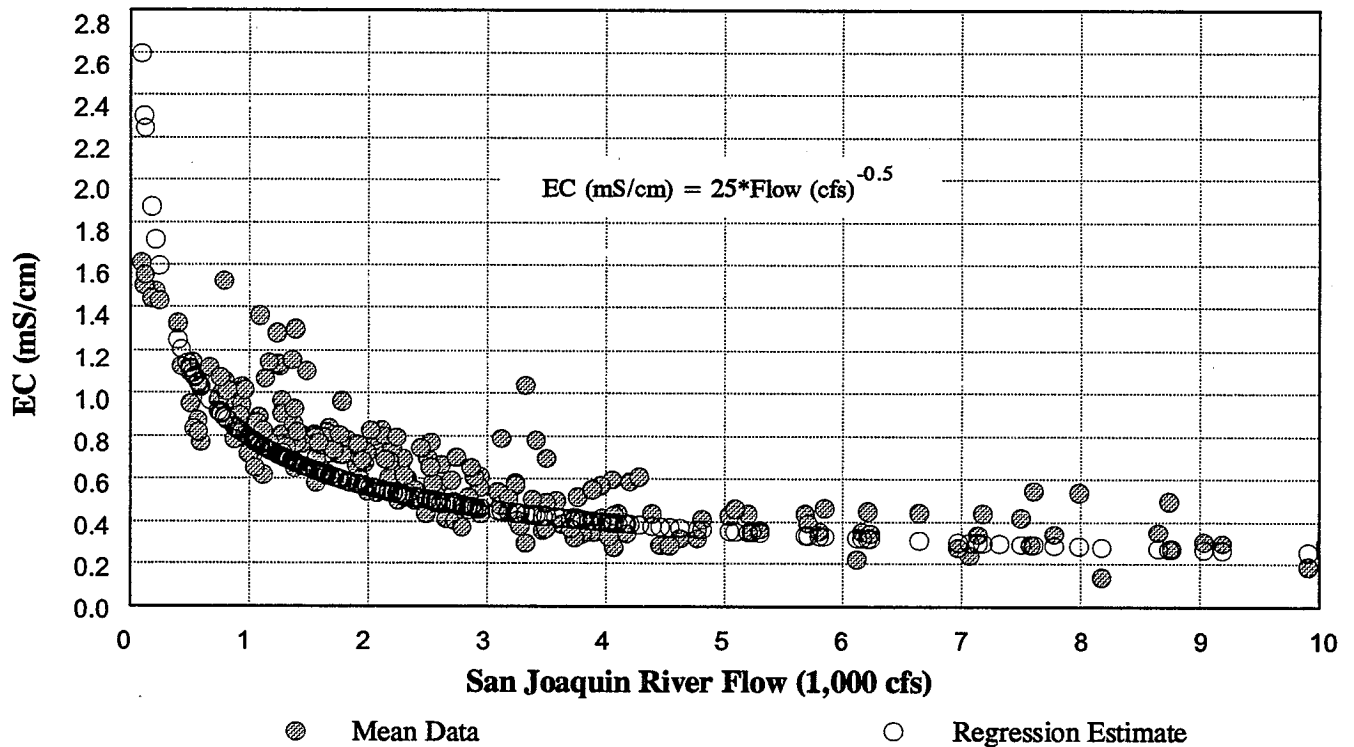
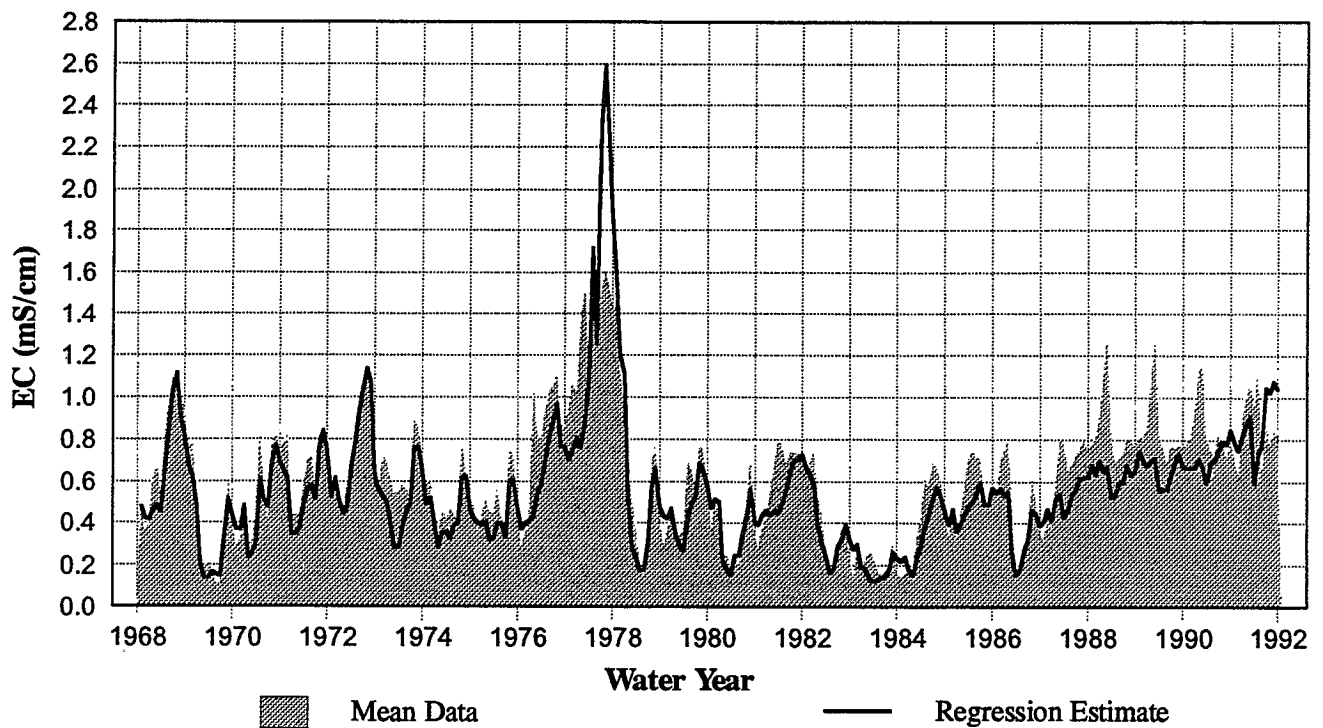


Figure B2-5.
Relationship between Simulated End-of-Month and
Measured Mean Monthly EC at Vernalis
and San Joaquin River Flow for 1968-1991

**DELTA WETLANDS
PROJECT EIR/EIS**
Prepared by: Jones & Stokes Associates

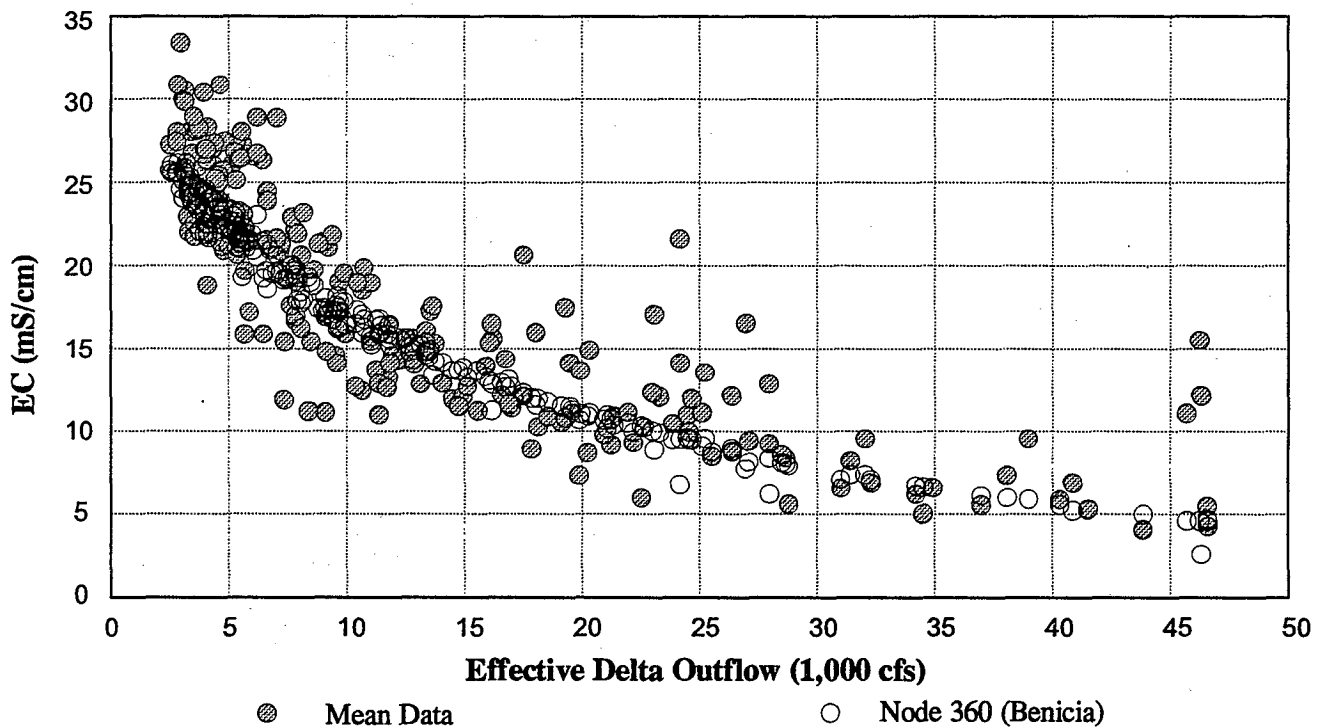
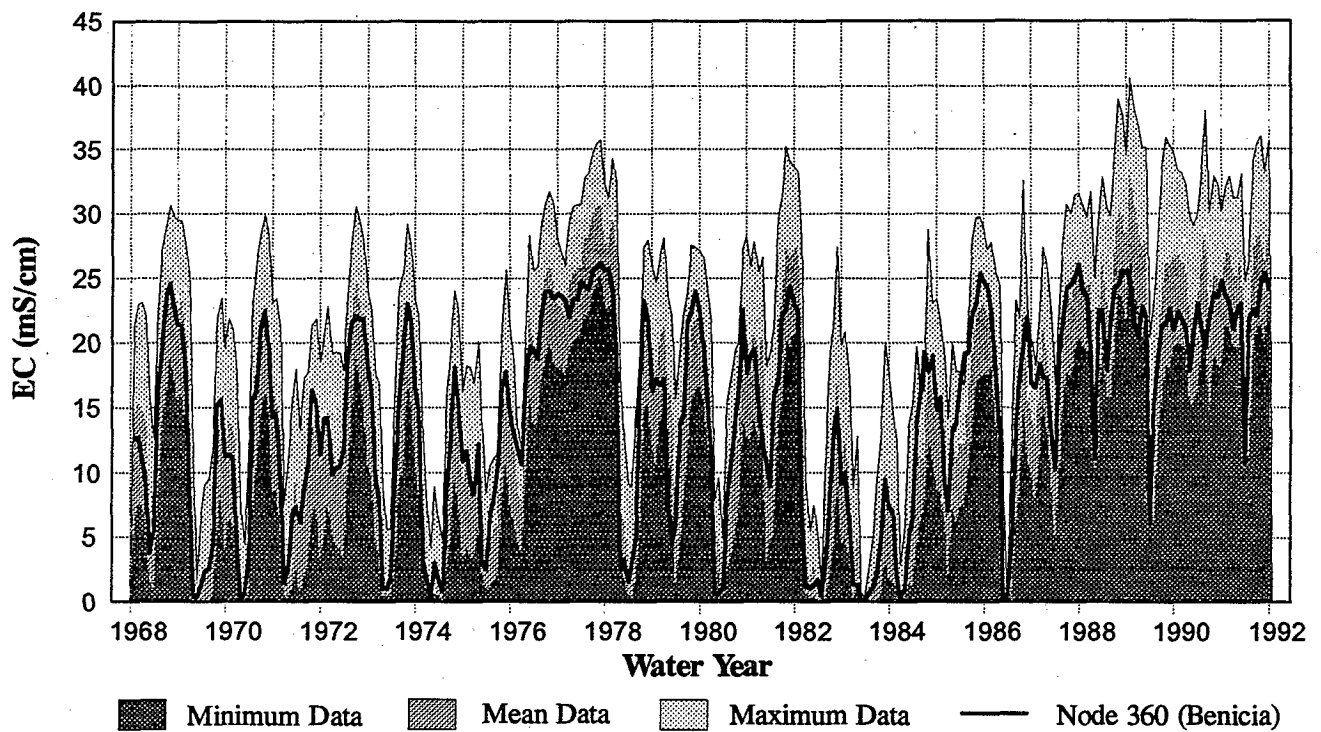


Figure B2-7.
Comparison of Simulated End-of-Month and
Measured Mean Monthly EC at Benicia
for Historical Delta Inflows and Exports
for 1968-1991

**DELTA WETLANDS
PROJECT EIR/EIS**
Prepared by: Jones & Stokes Associates

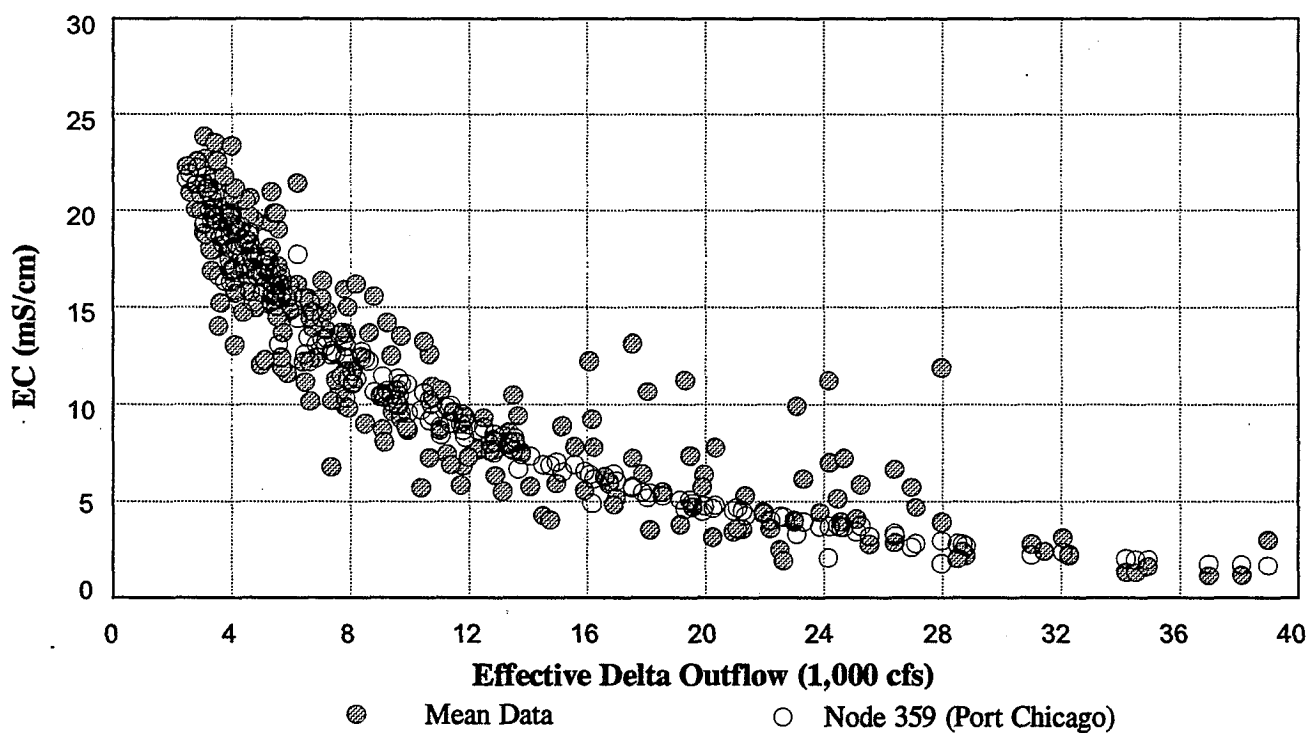
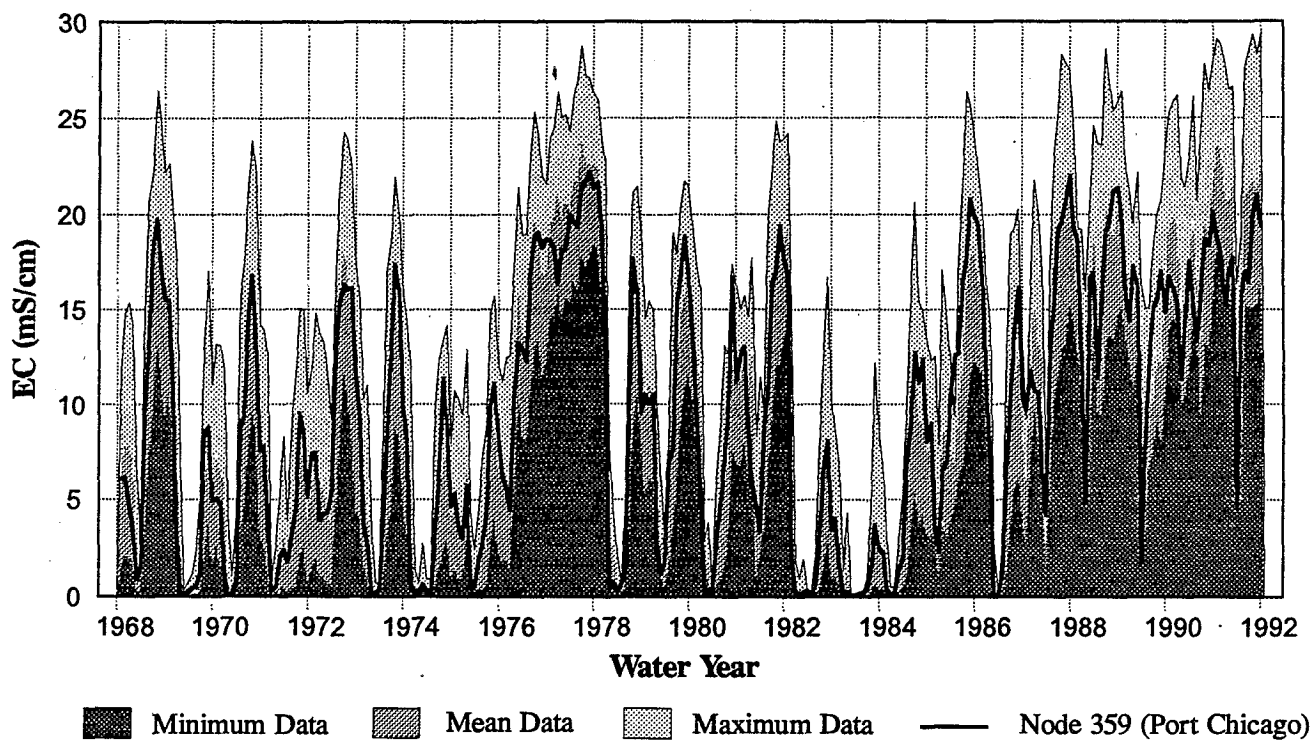


Figure B2-8.
Comparison of Simulated End-of-Month and
Measured Mean Monthly EC at Port Chicago
for Historical Delta Inflows and Exports
for 1968-1991

DELTA WETLANDS
PROJECT EIR/EIS
Prepared by: Jones & Stokes Associates

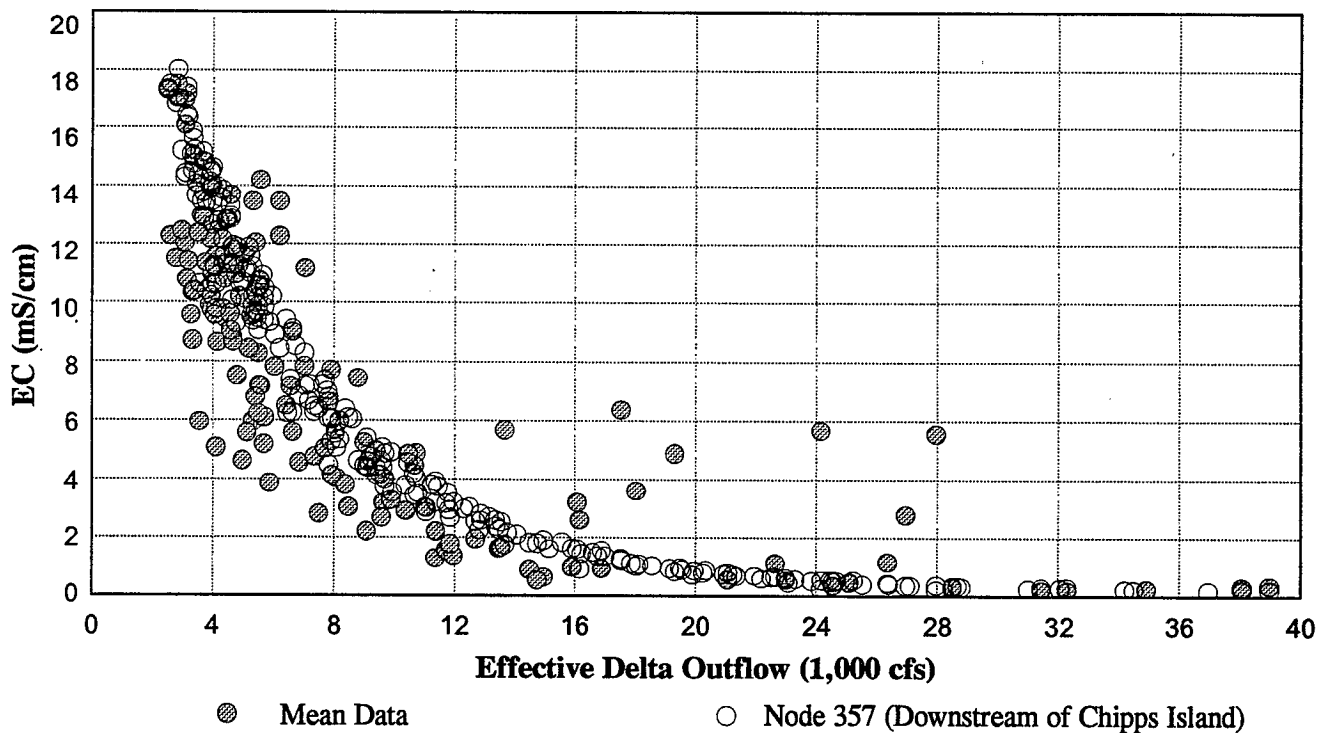
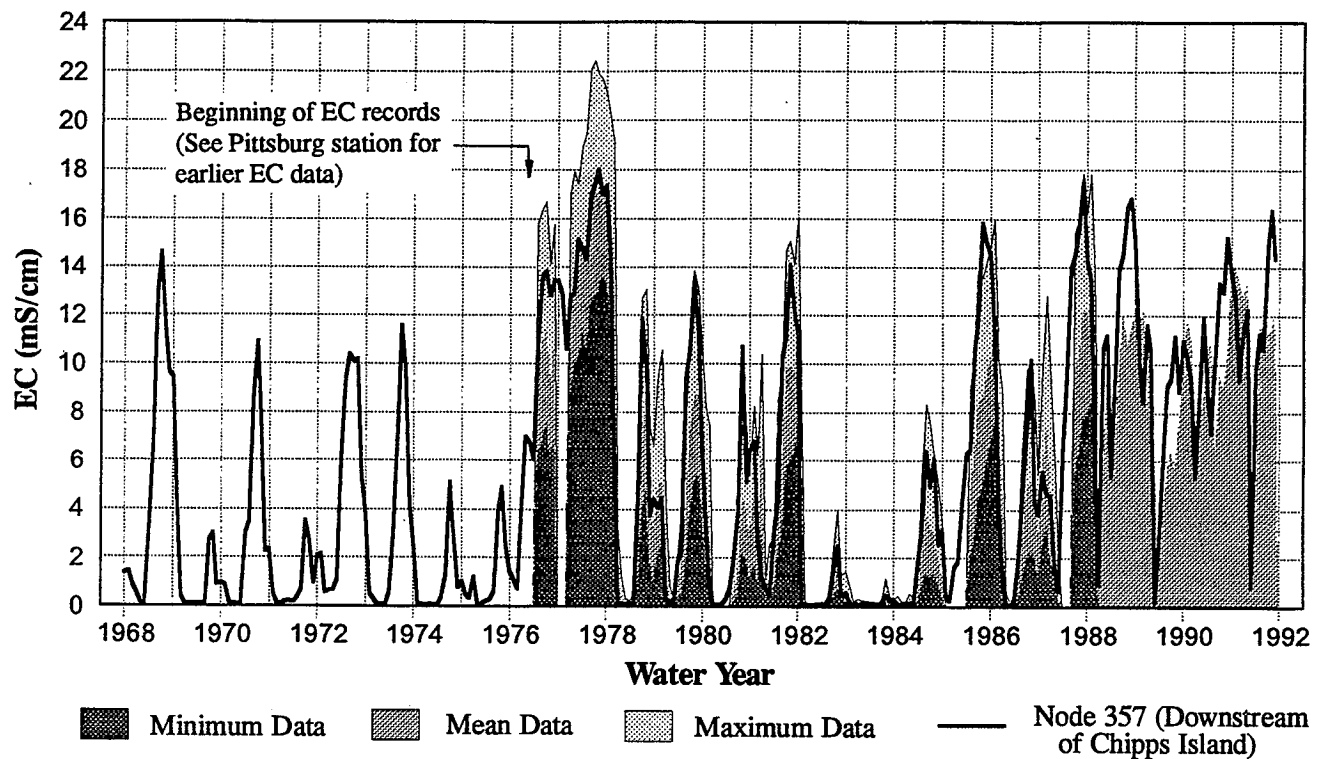


Figure B2-9.
Comparison of Simulated End-of Month and
Measured Mean Monthly EC at Chipps Island
for Historical Delta Inflows and Exports
for 1968-1991

**DELTA WETLANDS
PROJECT EIR/EIS**
Prepared by: Jones & Stokes Associates

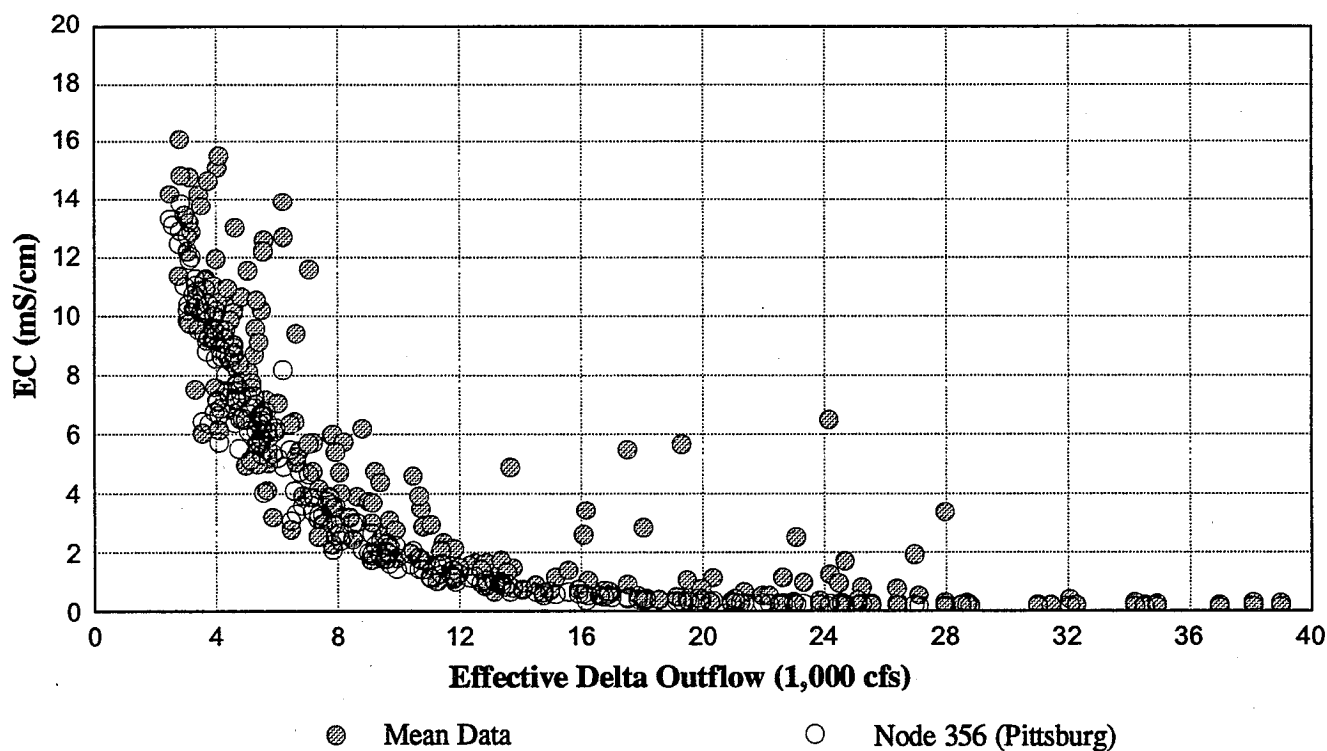
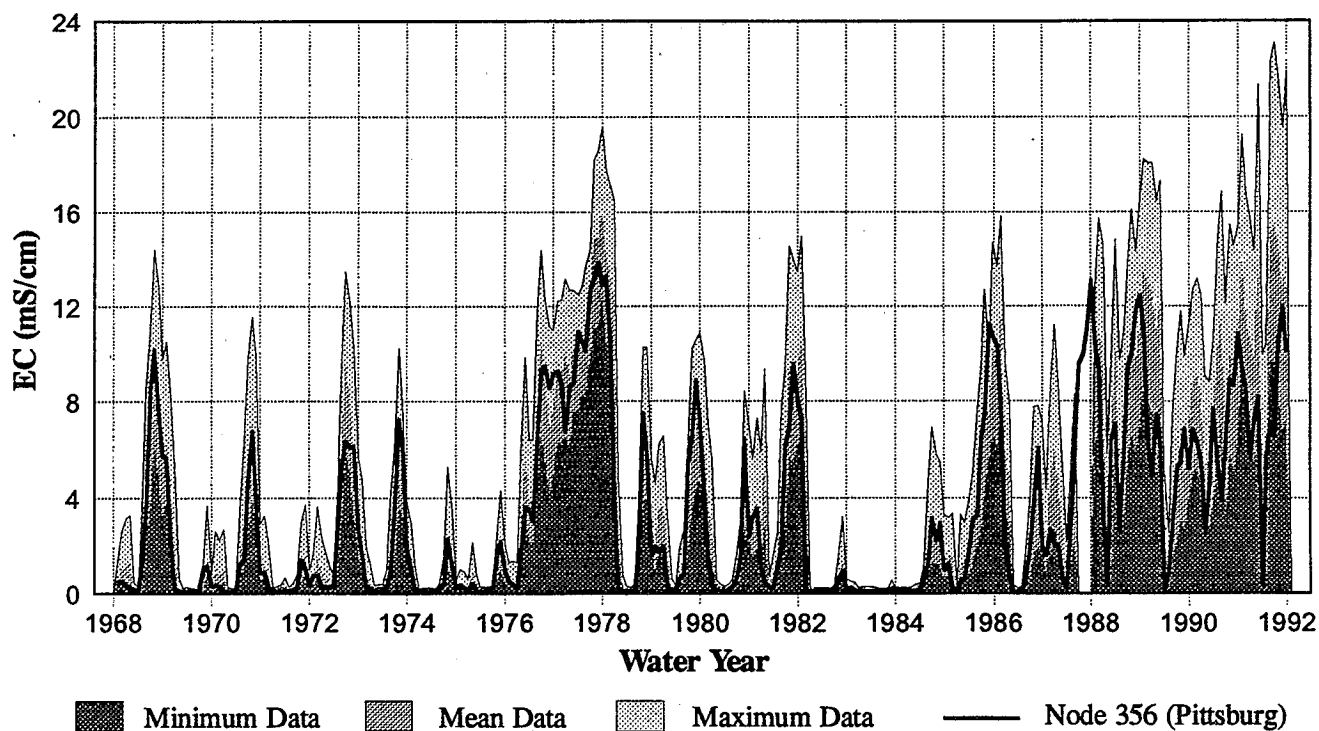


Figure B2-10.
Comparison of Simulated End-of-Month and
Measured Mean Monthly EC at Pittsburg
for Historical Delta Inflows and Exports
for 1968-1991

**DELTA WETLANDS
PROJECT EIR/EIS**
Prepared by: Jones & Stokes Associates

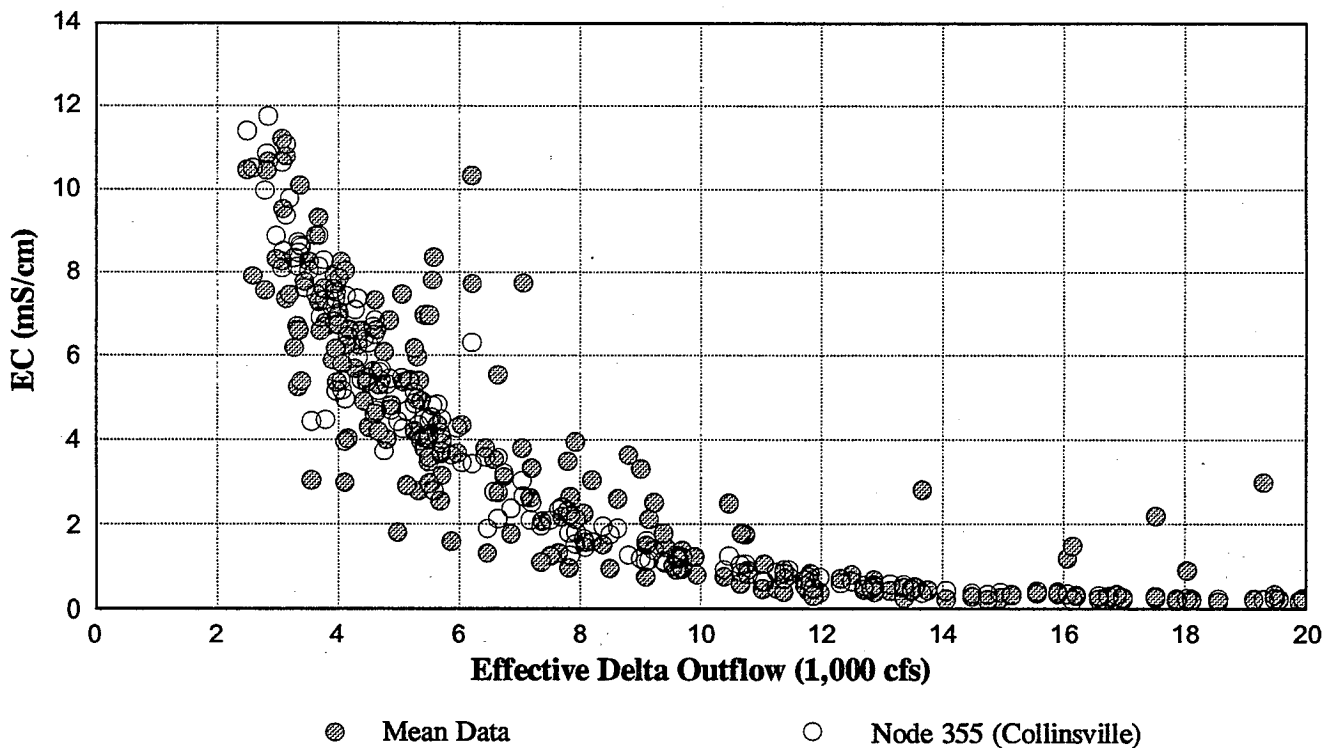
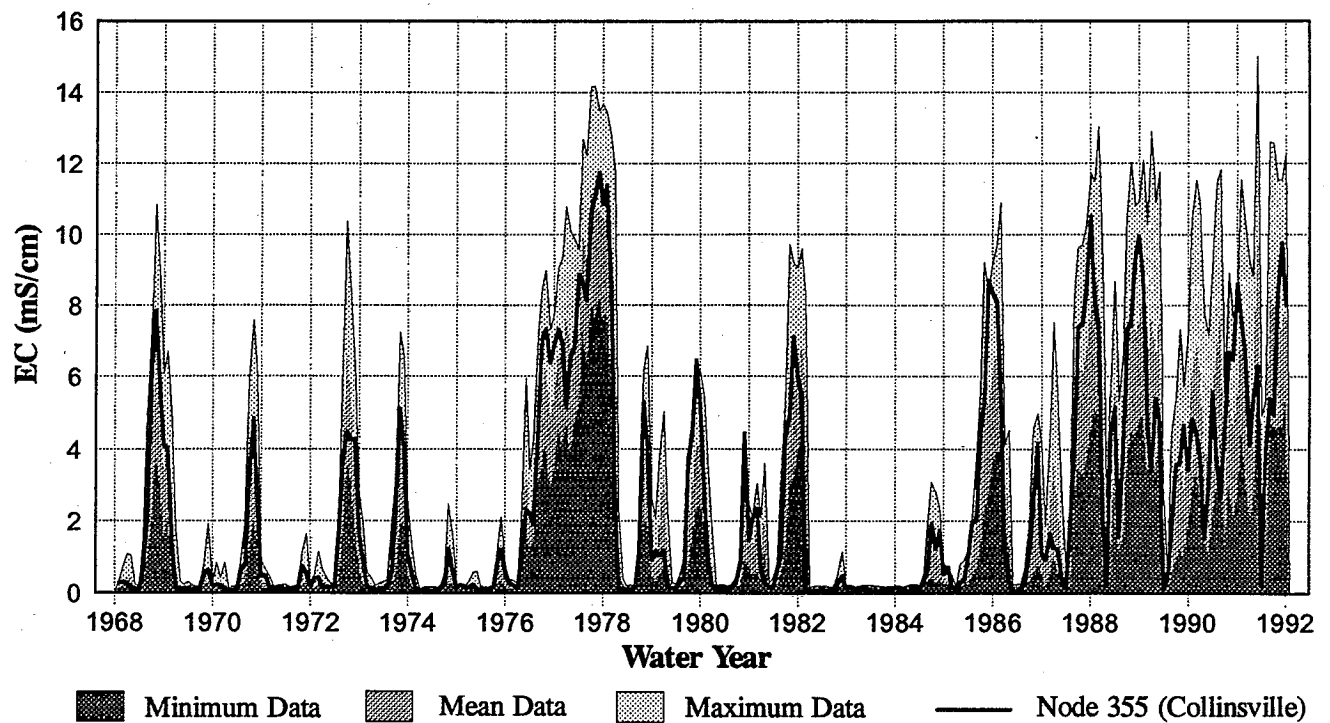


Figure B2-11.
Comparison of Simulated End-of-Month and
Measured Mean Monthly EC at Collinsville
for Historical Delta Inflows and Exports
for 1968-1991

**DELTA WETLANDS
PROJECT EIR/EIS**
Prepared by: Jones & Stokes Associates

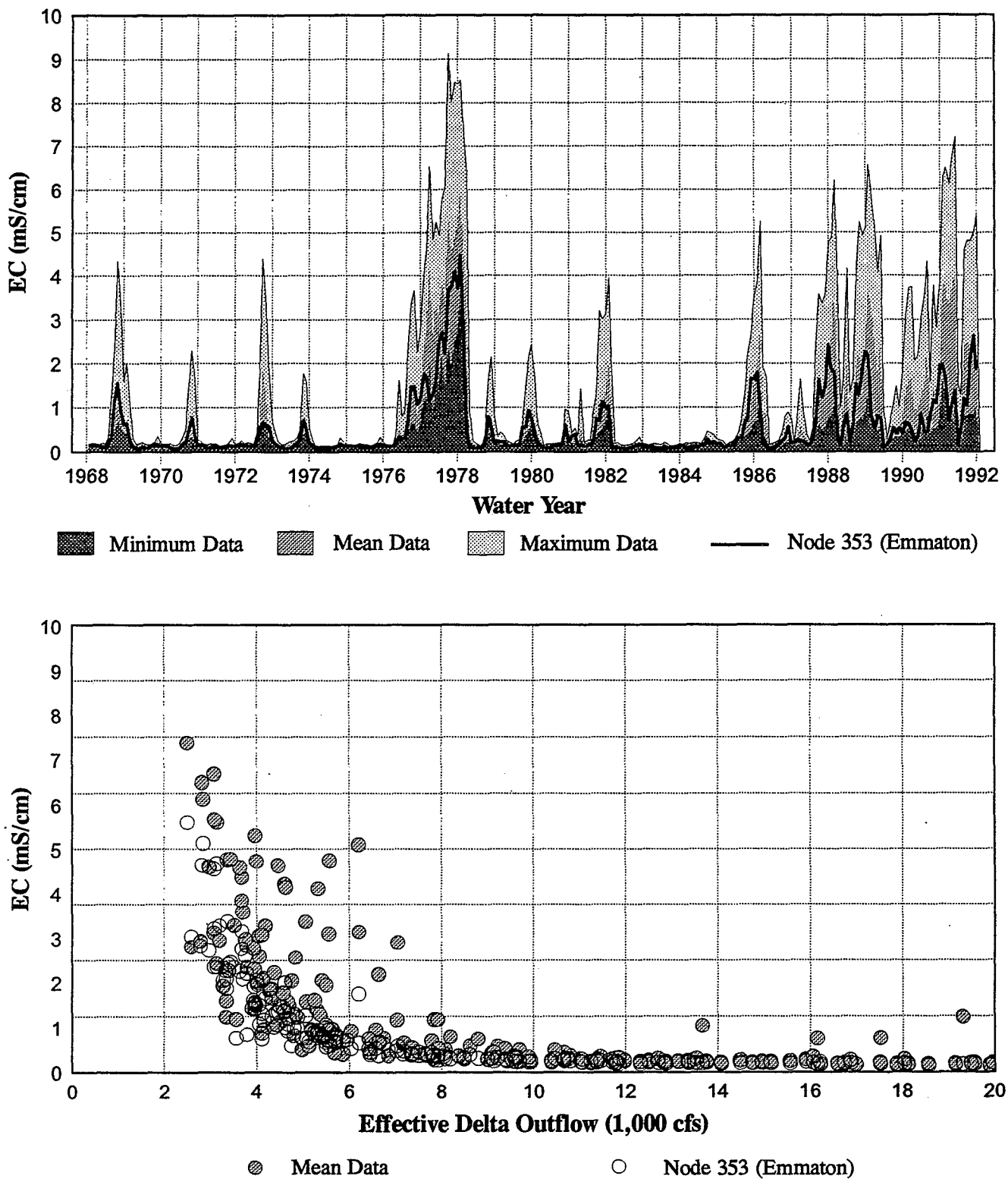


Figure B2-12.
Comparison of Simulated End-of-Month and
Measured Mean Monthly EC at Emmaton
for Historical Delta Inflows and Exports
for 1968-1991

**DELTA WETLANDS
PROJECT EIR/EIS**
Prepared by: Jones & Stokes Associates

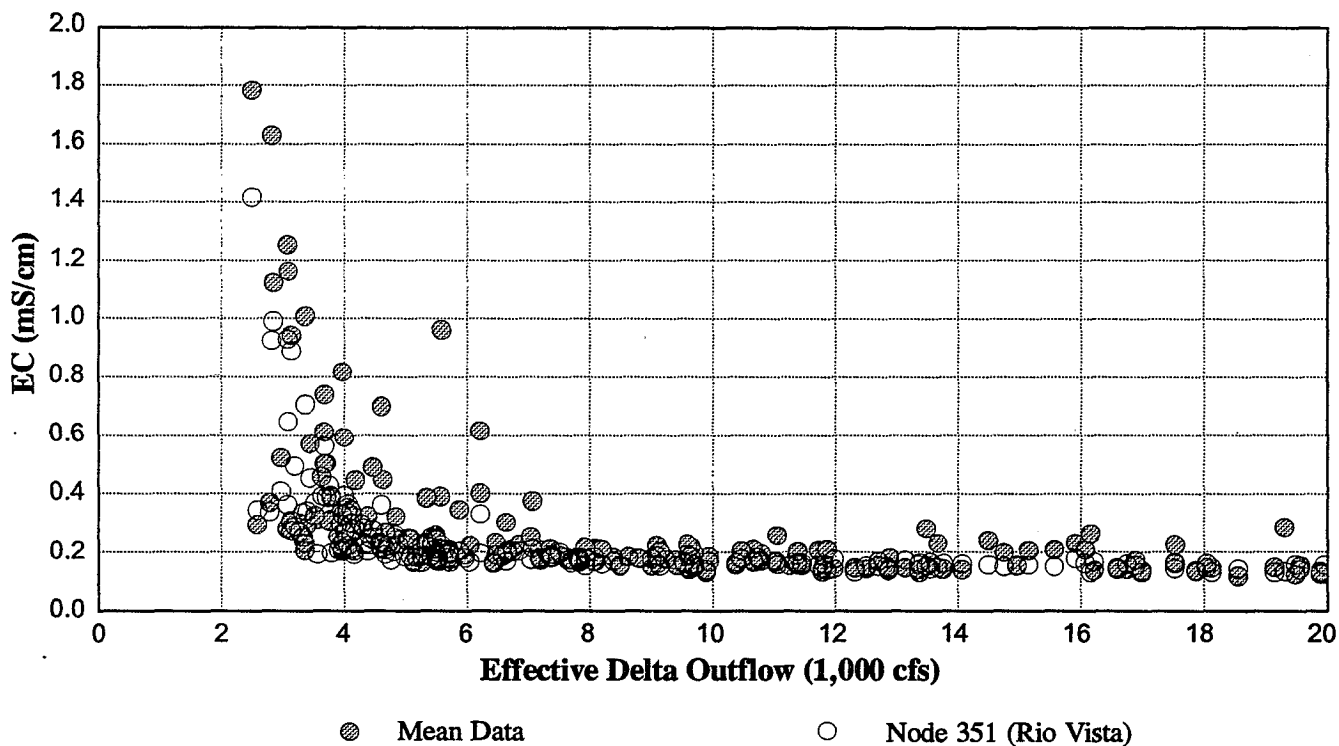
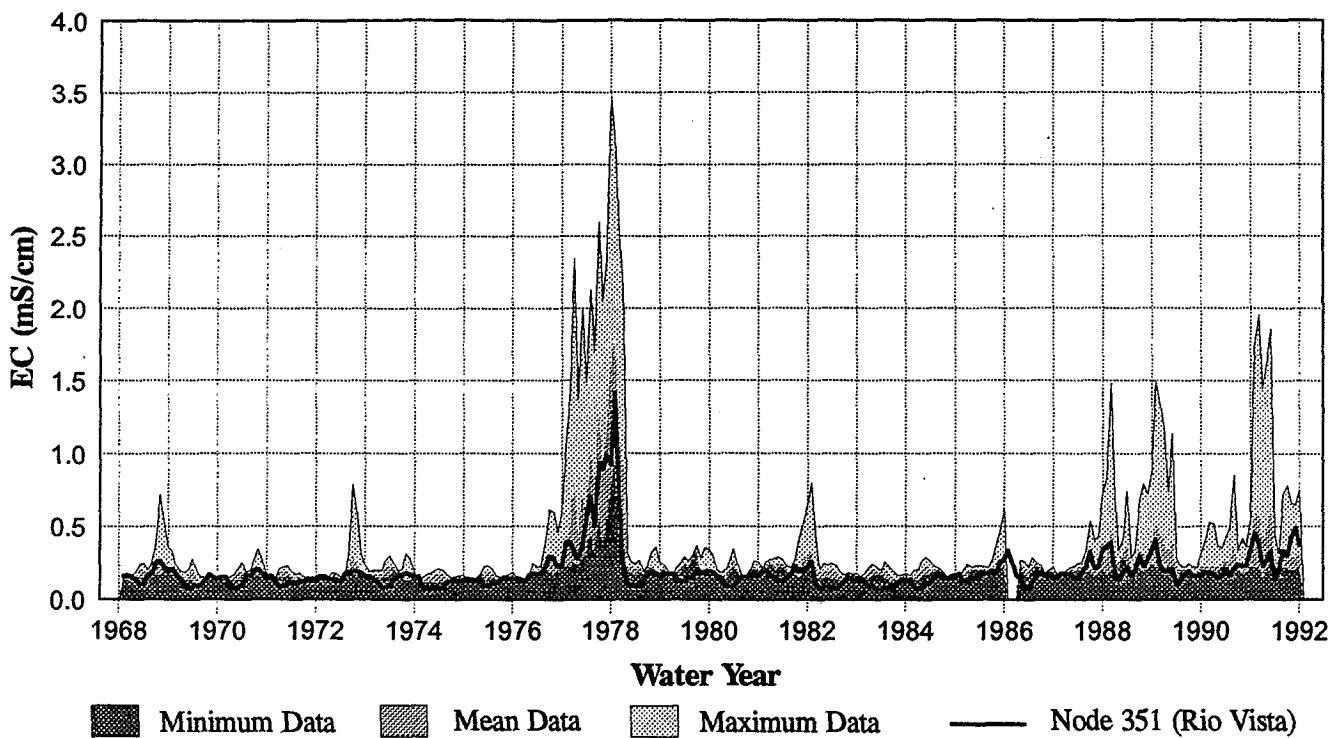


Figure B2-13.
Comparison of Simulated End-of-Month and
Measured Mean Monthly EC at Rio Vista
for Historical Delta Inflows and Exports
for 1968-1991

**DELTA WETLANDS
PROJECT EIR/EIS**
Prepared by: Jones & Stokes Associates

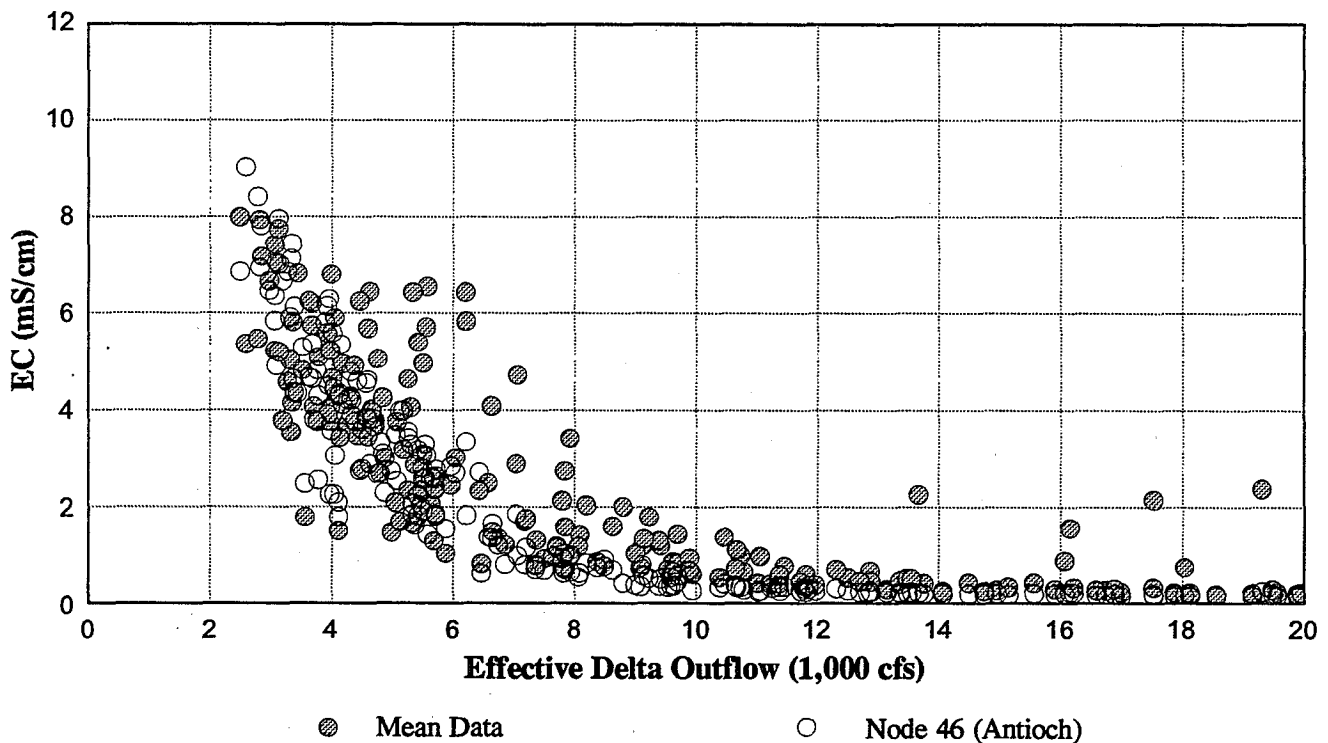
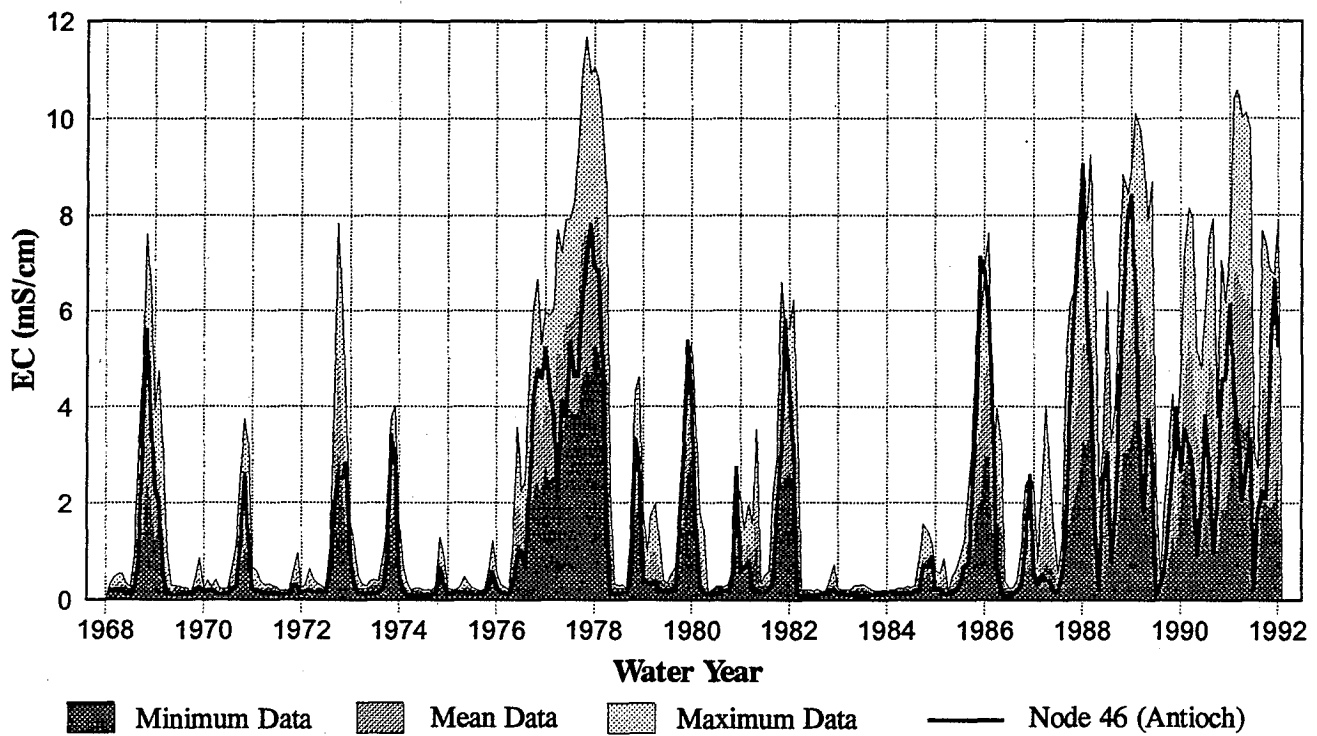


Figure B2-14.
Comparison of Simulated End-of-Month and
Measured Mean Monthly EC at Antioch
for Historical Delta Inflows and Exports
for 1968-1991

**DELTA WETLANDS
PROJECT EIR/EIS**
Prepared by: Jones & Stokes Associates

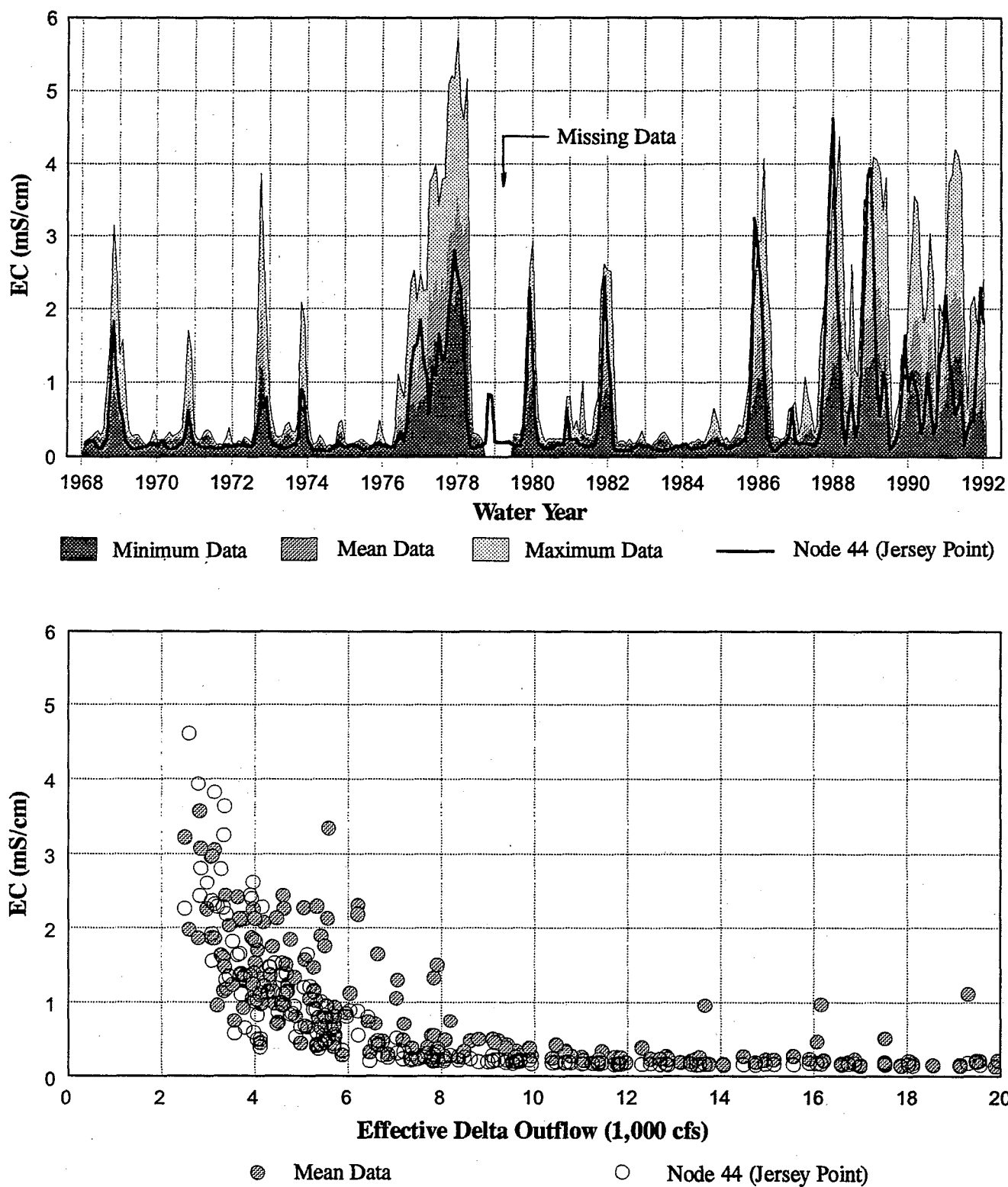


Figure B2-15.
Comparison of Simulated End-of-Month and
Measured Mean Monthly EC at Jersey Point
for Historical Delta Inflows and Exports
for 1968-1991

**DELTA WETLANDS
PROJECT EIR/EIS**
Prepared by: Jones & Stokes Associates

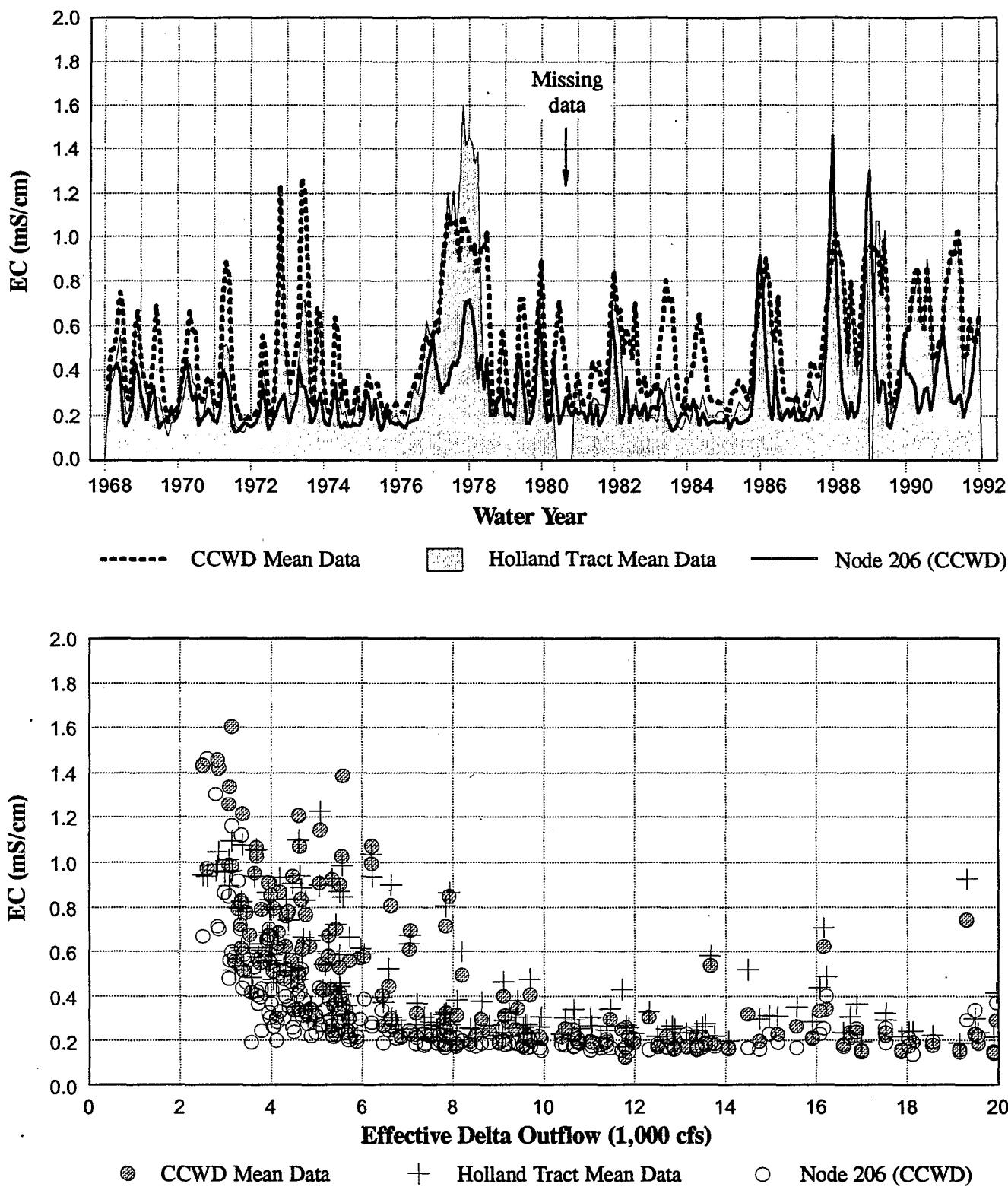


Figure B2-16.
Comparison of Simulated End-of-Month and
Measured Mean Monthly EC at Holland Tract
and CCWD Canal for Historical Delta Inflows
and Exports for 1968-1991

**DELTA WETLANDS
PROJECT EIR/EIS**
Prepared by: Jones & Stokes Associates

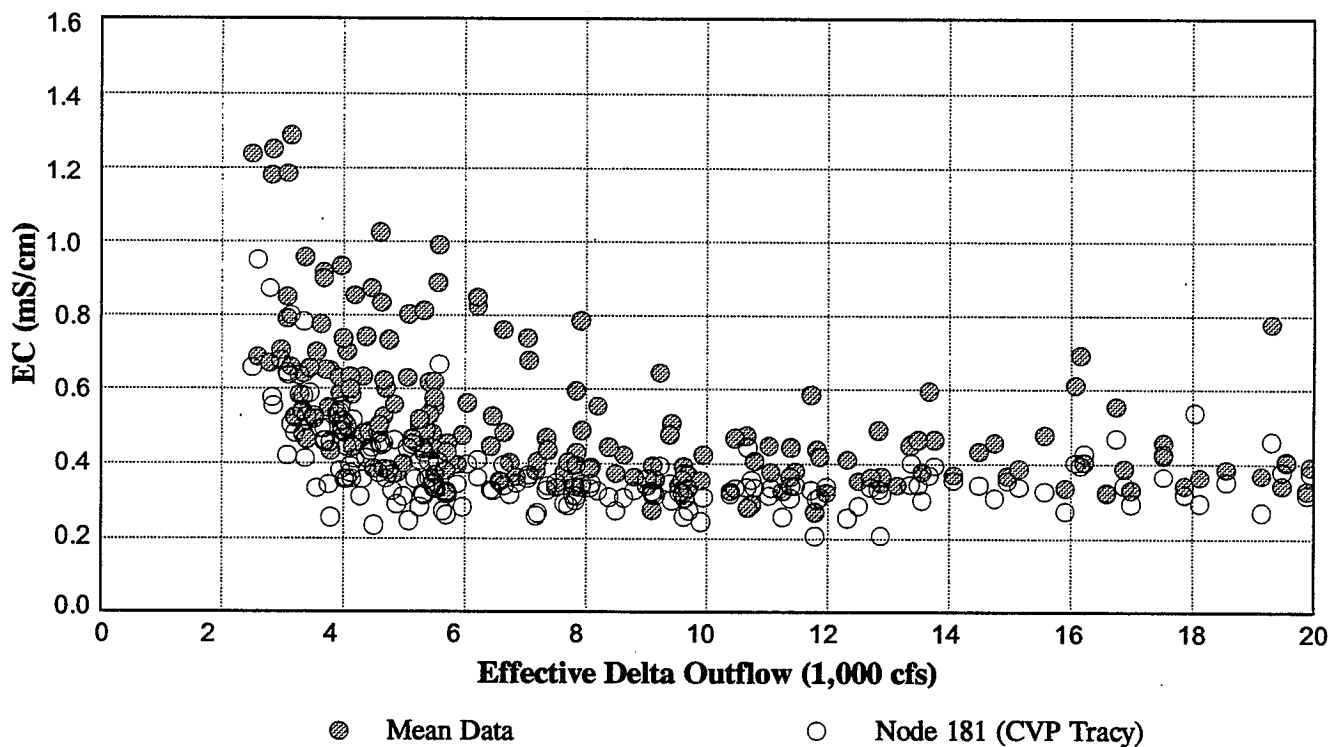
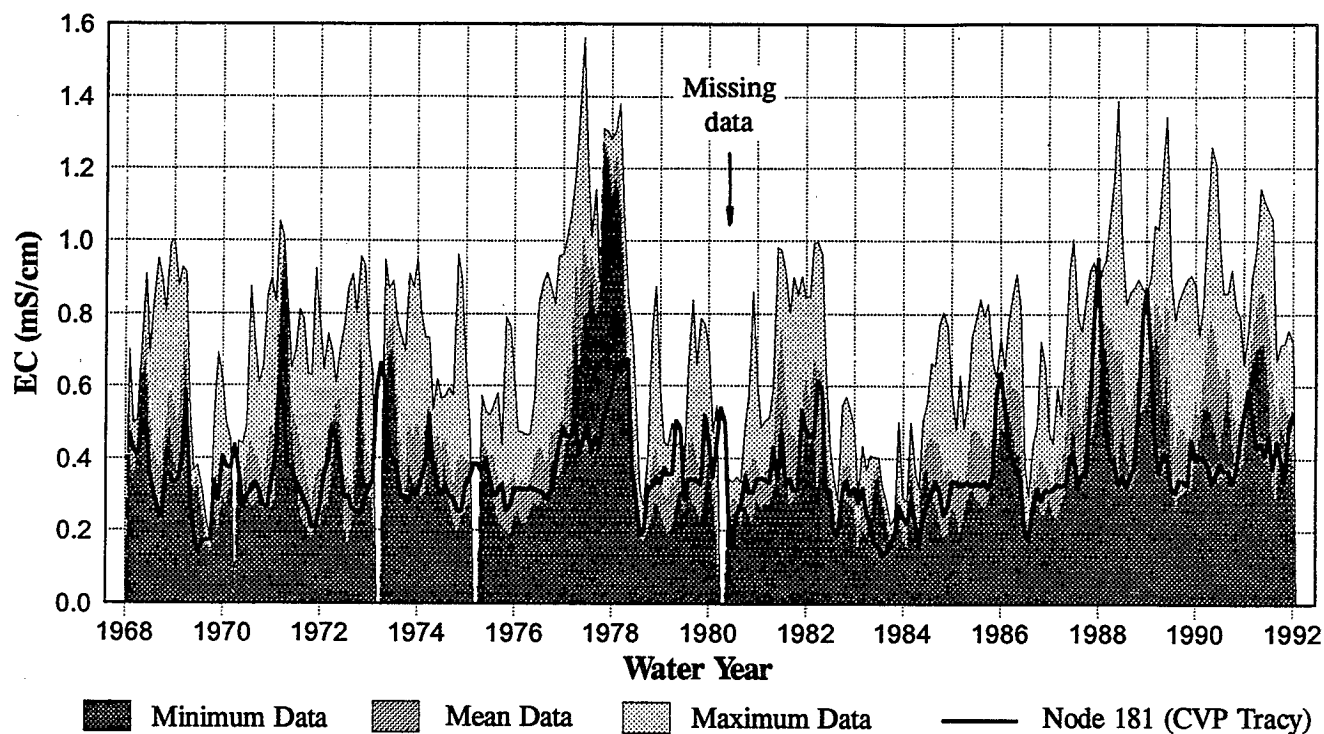


Figure B2-17.
Comparison of Simulated End-of-Month and
Measured Mean Monthly EC at the CVP Tracy
Pumping Plant for Historical Delta Inflows
and Exports for 1968-1991

**DELTA WETLANDS
PROJECT EIR/EIS**
Prepared by: Jones & Stokes Associates

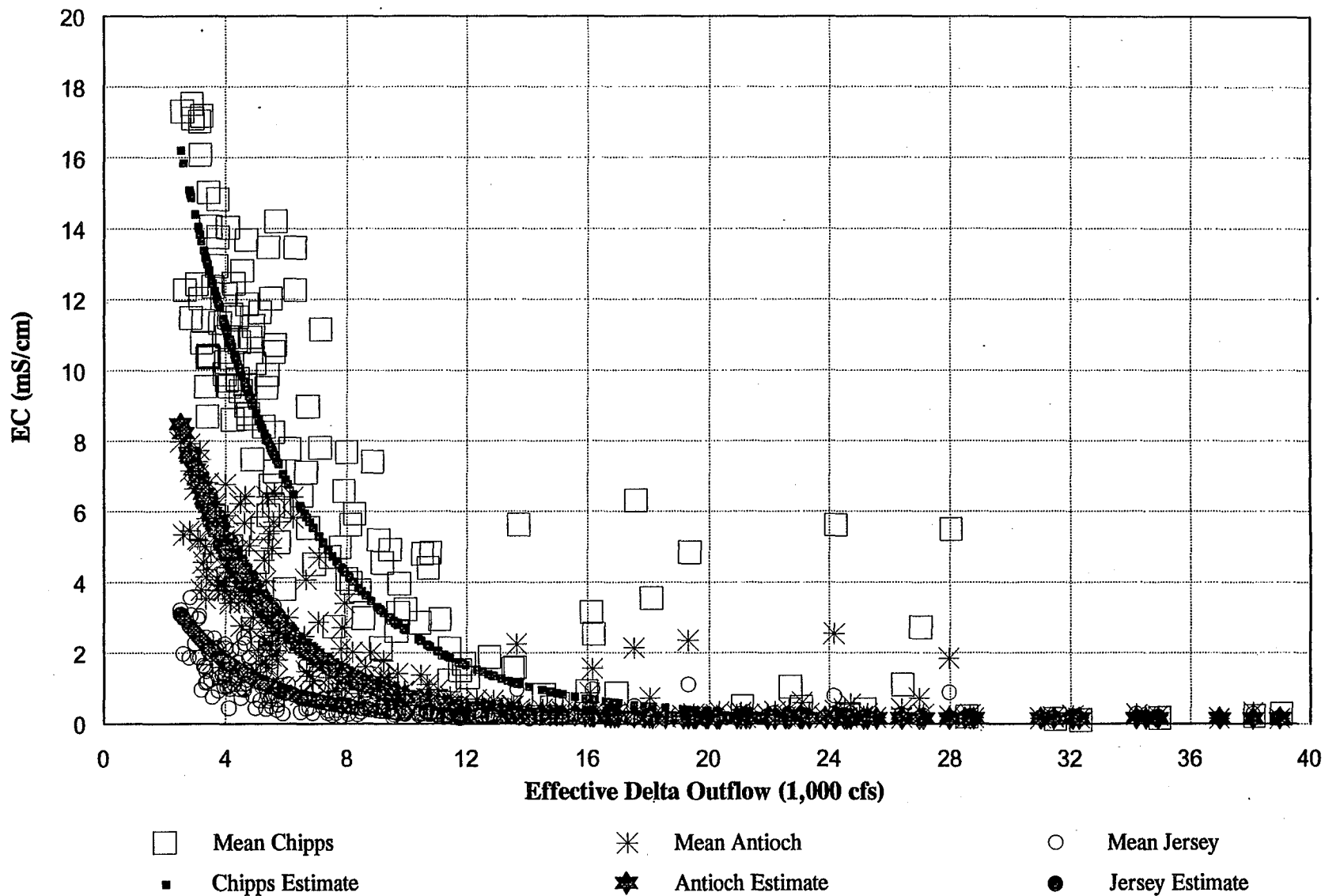


Figure B2-18.
 Relationship between Simulated End-of-Month and Measured Mean
 Monthly EC at Selected Delta Channel Locations for 1968-1991

DELTA WETLANDS
PROJECT EIR/EIS
 Prepared by: Jones & Stokes Associates

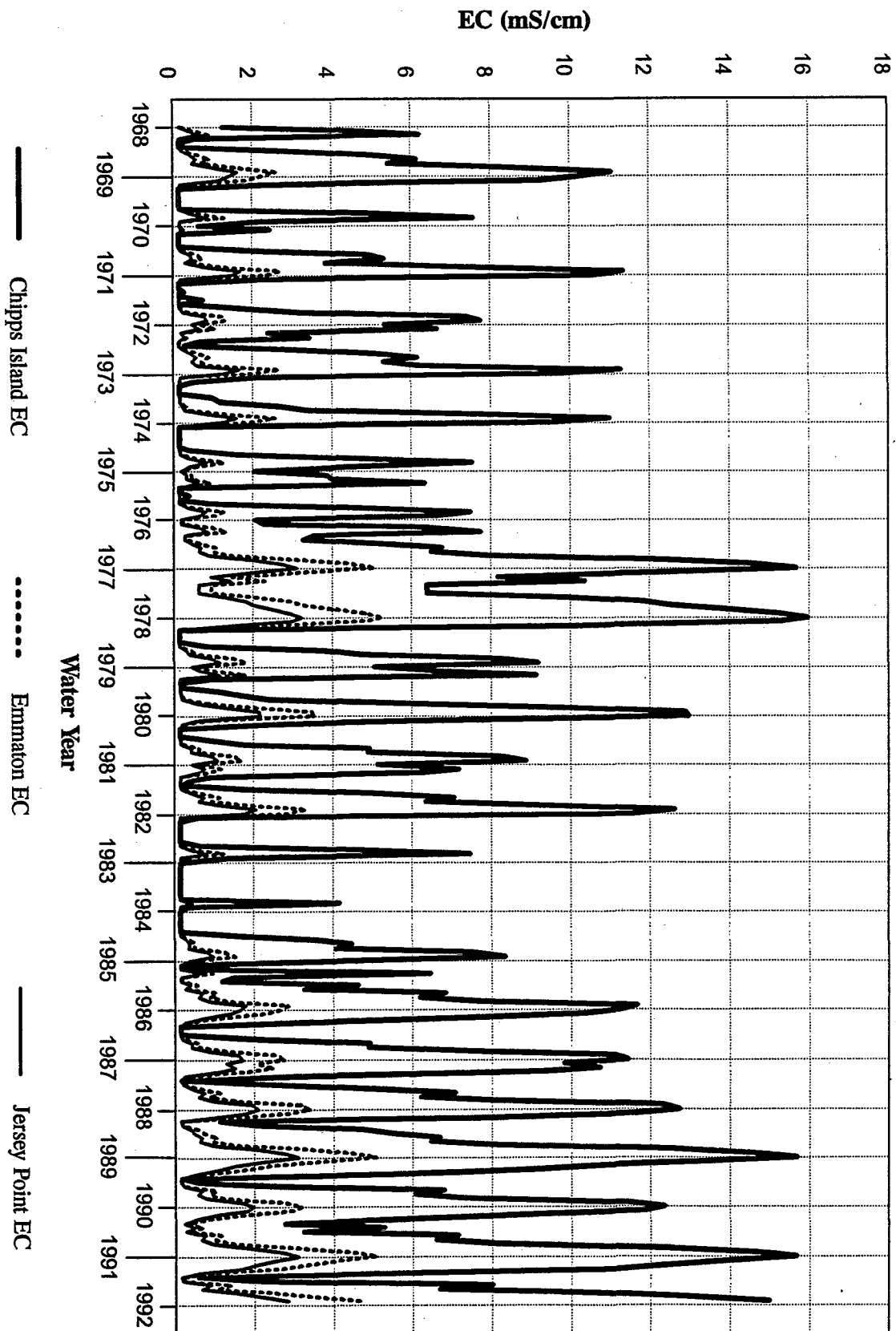


Figure B2-19.
 Simulated Patterns of Monthly EC at Selected Delta Channel Locations
 under the No-Project Alternative for 1968-1991

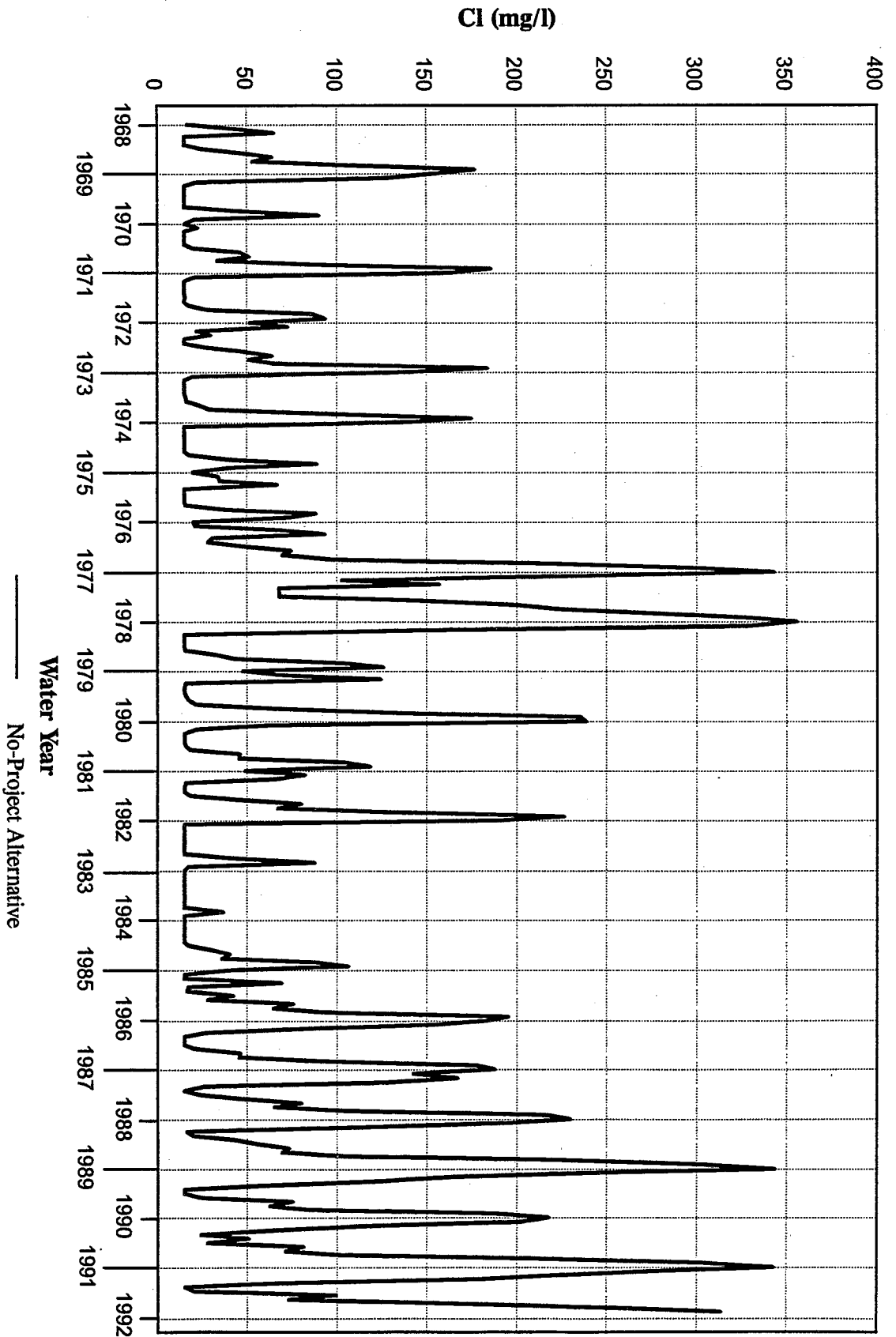


Figure B2-20.
 Simulated Patterns of Export Chloride
 under the No-Project Alternative for 1968-1991

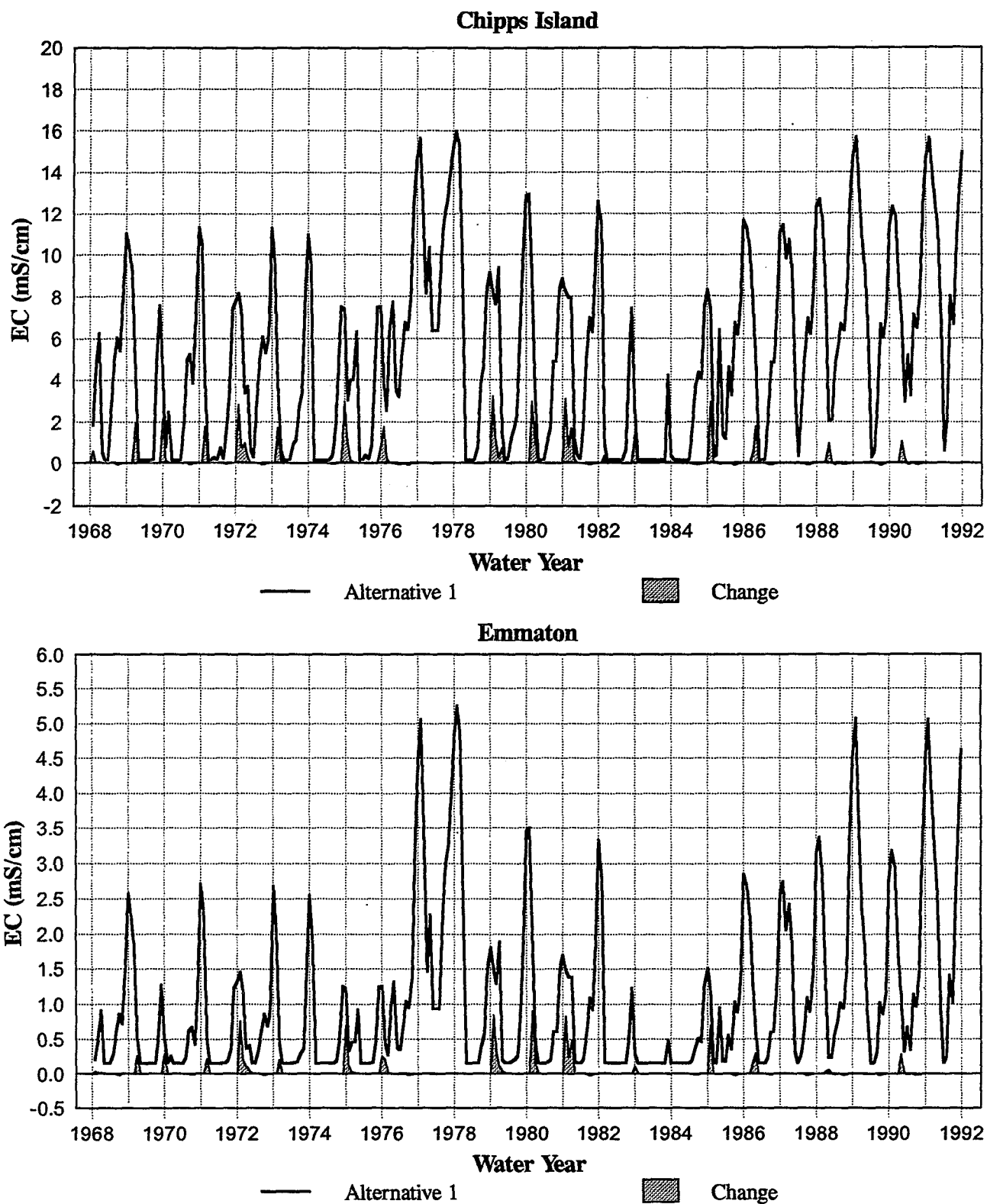


Figure B2-21.
 Simulated End-of-Month Values and Predicted Changes
 for EC under Alternative 1 Operations
 at Chipps Island and Emmaton for 1968-1991

DELTA WETLANDS
PROJECT EIR/EIS
 Prepared by: Jones & Stokes Associates

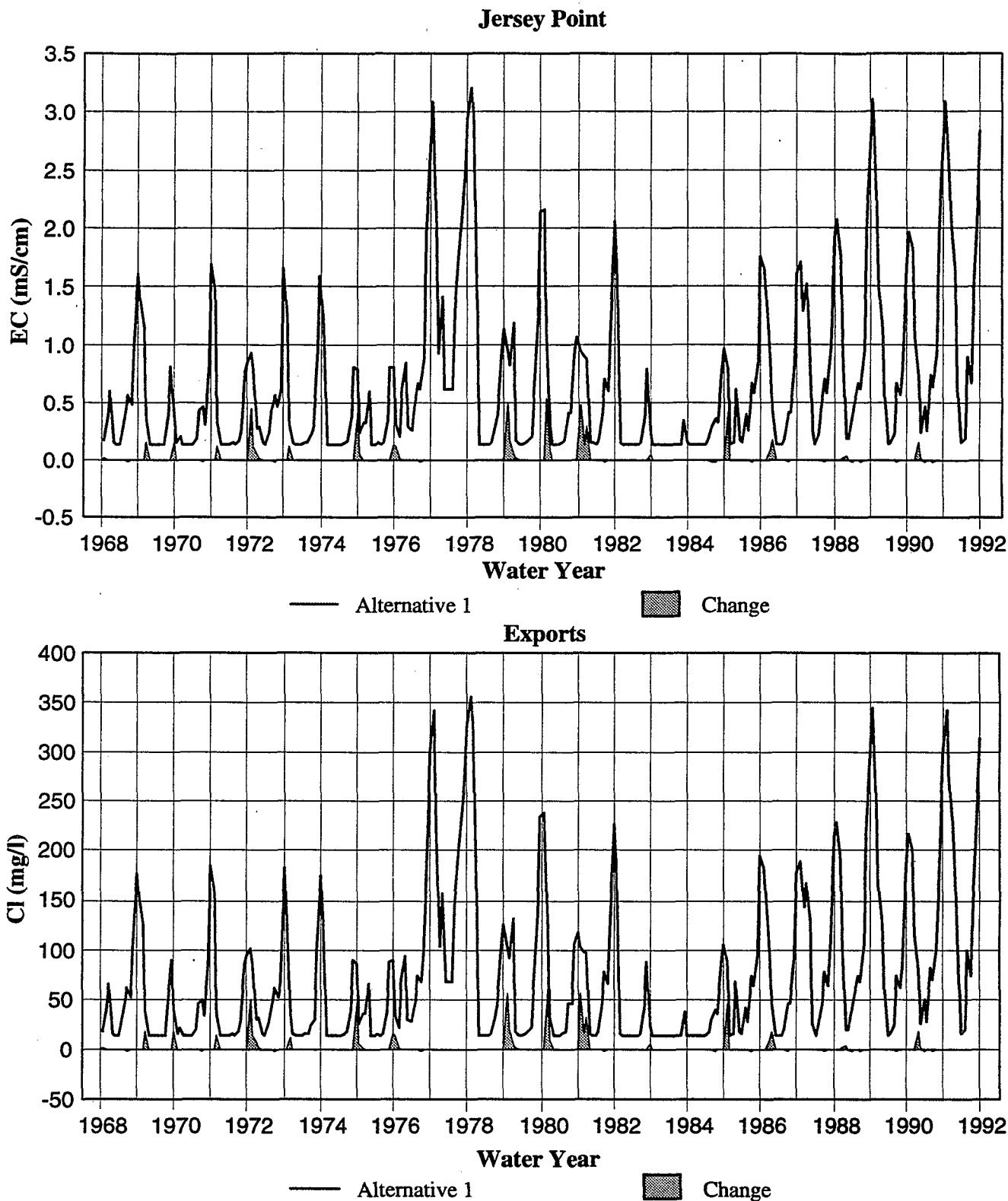


Figure B2-22.
 Simulated End-of-Month Values and Predicted Changes
 under Alternative 1 Operations for Jersey Point EC
 and Export Chloride for 1968-1991

**DELTA WETLANDS
 PROJECT EIR/EIS**
 Prepared by: Jones & Stokes Associates

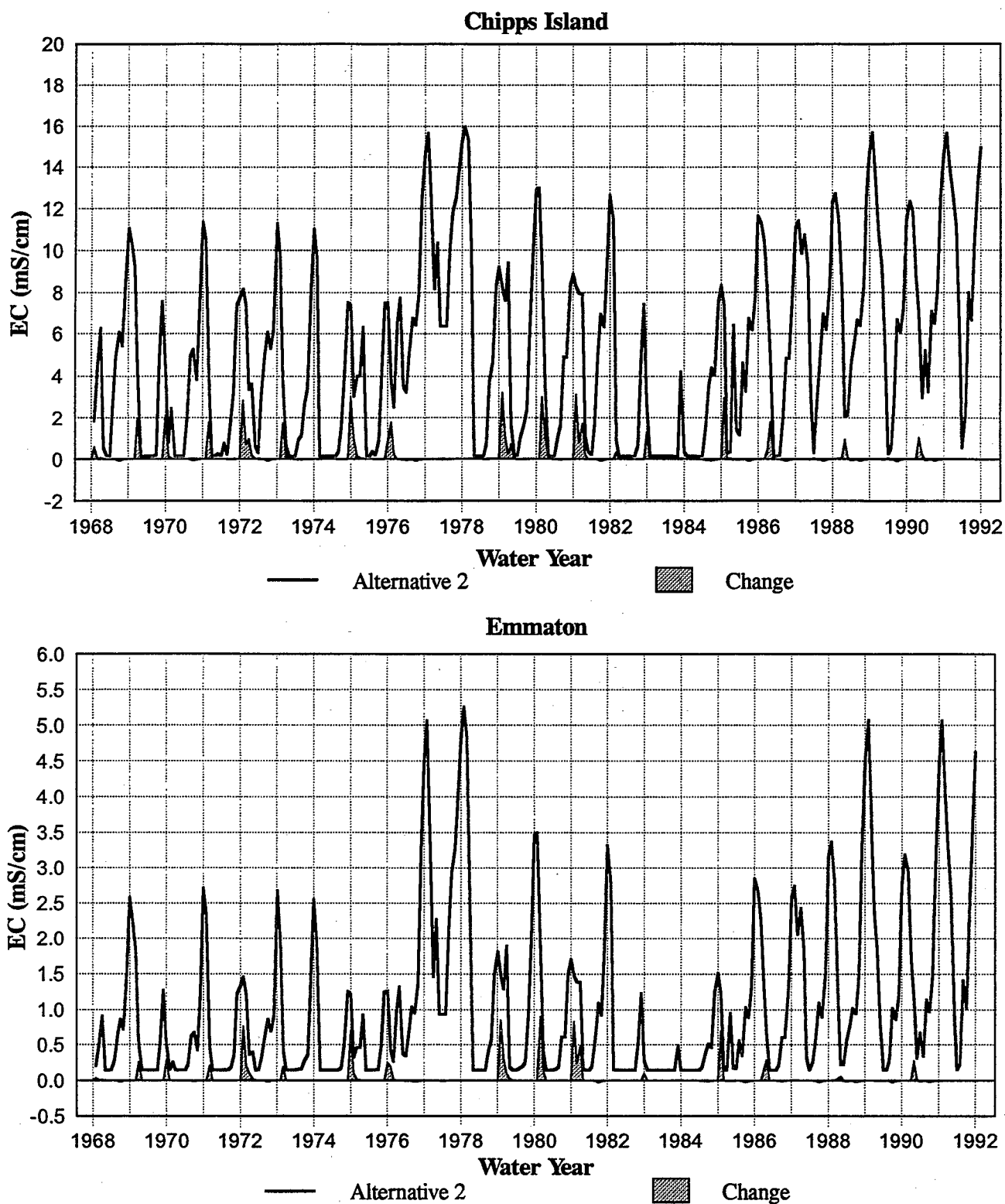


Figure B2-23.
 Simulated End-of-Month Values and Predicted Changes
 for EC under Alternative 2 Operations
 at Chipps Island and Emmaton for 1968-1991

DELTA WETLANDS
PROJECT EIR/EIS
 Prepared by: Jones & Stokes Associates

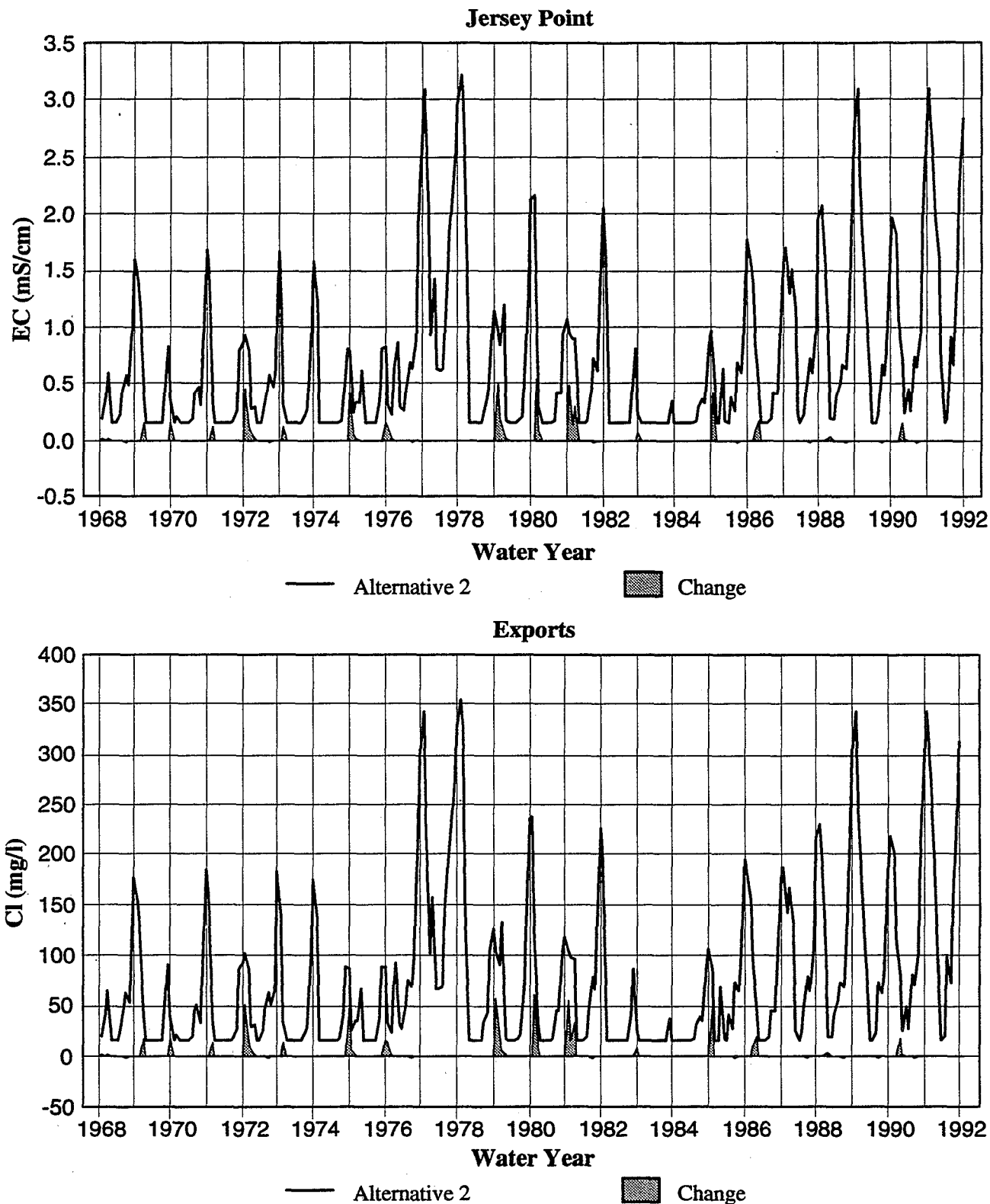


Figure B2-24.
 Simulated End-of-Month Values and Predicted Changes
 under Alternative 2 Operations for Jersey Point EC
 and Export Chloride 1968-1991

DELTA WETLANDS
PROJECT EIR/EIS
 Prepared by: Jones & Stokes Associates

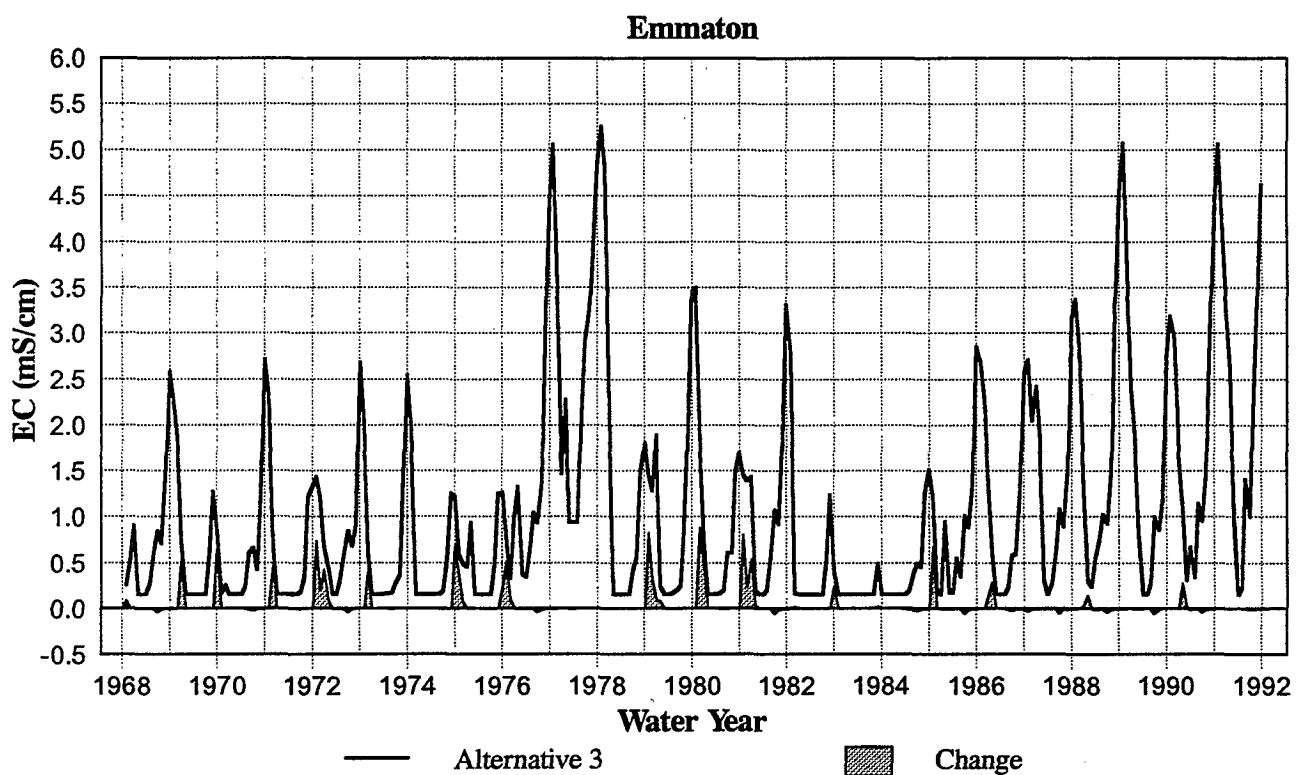
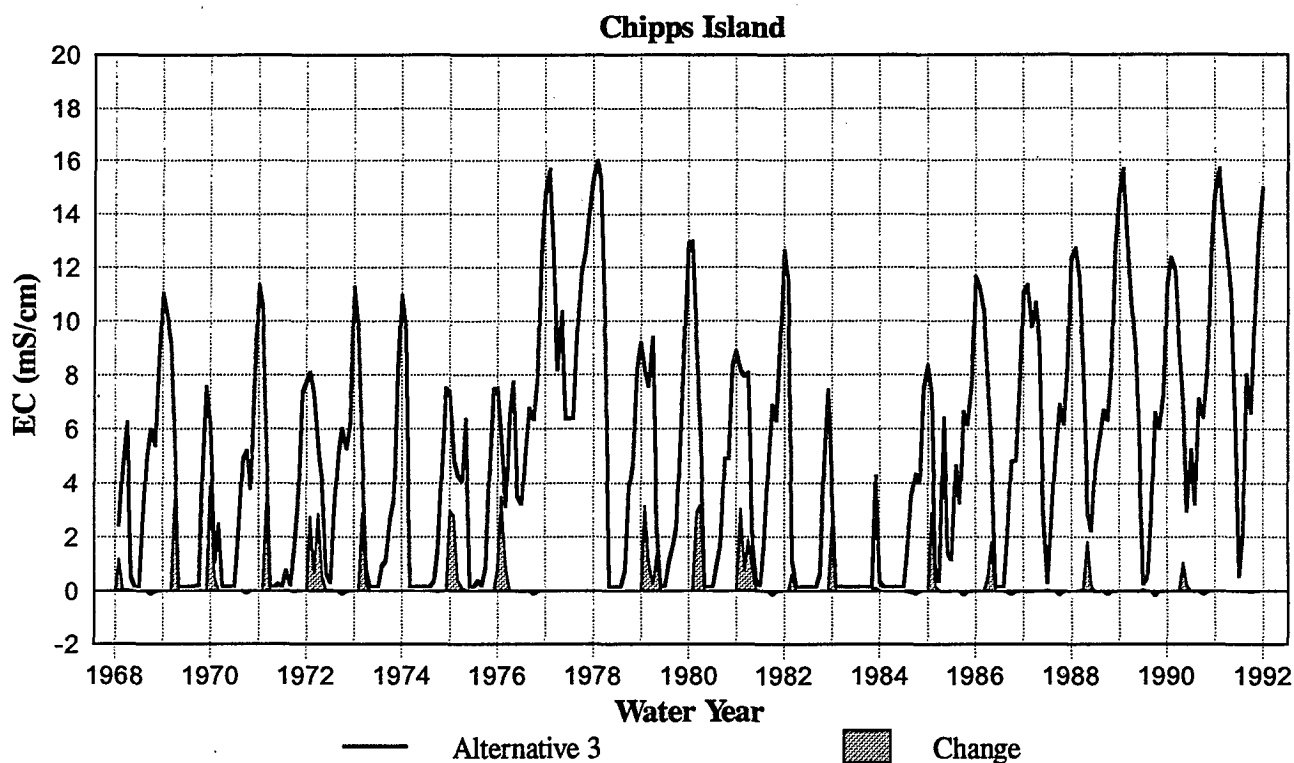


Figure B2-25.
 Simulated End-of-Month Values and Predicted Changes
 for EC under Alternative 3 Operations
 at Chipps Island and Emmaton for 1968-1991

**DELTA WETLANDS
 PROJECT EIR/EIS**
 Prepared by: Jones & Stokes Associates

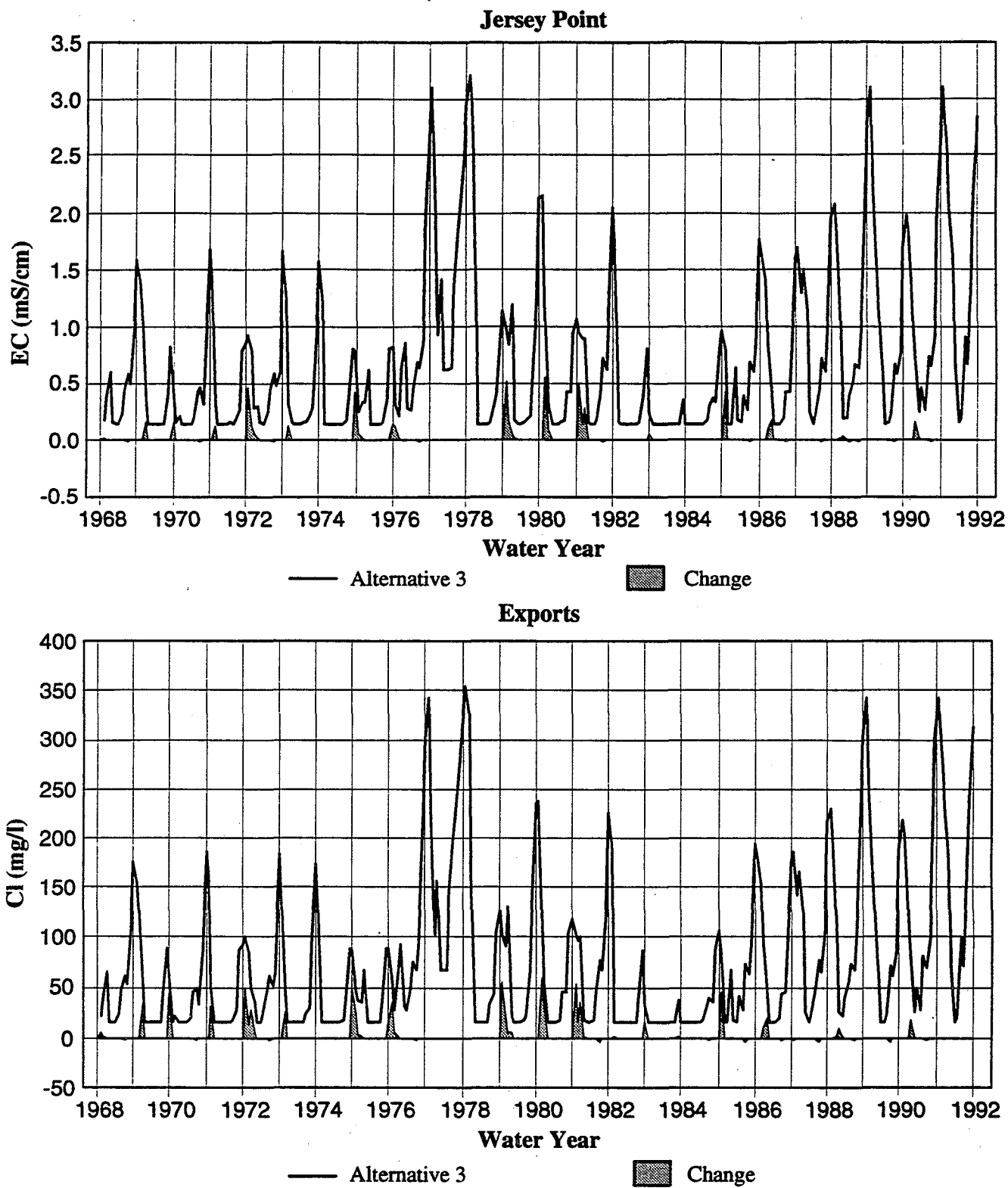


Figure B2-26.
 Simulated End-of-Month Values and Predicted Changes
 under Alternative 3 Operations for Jersey Point EC and
 Export Chloride for 1968-1991

DELTA WETLANDS
PROJECT EIR/EIS
 Prepared by: Jones & Stokes Associates